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OFFICE OF
PREVENTION, PESTICIDES, AND
TOXIC SUBSTANCES

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MEMORANDUM:

SUBJECT: Revised EFED Risk Assessment of Carbaryl in Support of the Reregistration Eligibility Decision (RED)

To: Anthony Britten, PM Team Reviewer
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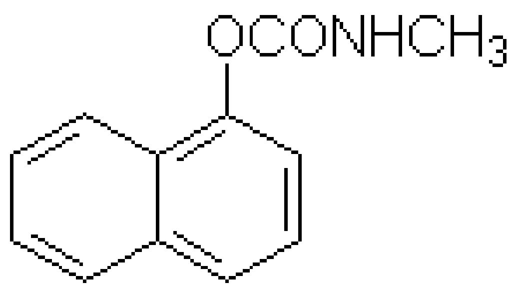
The Environmental Fate and Effects Division has revised the Environmental Fate and Ecological Risk Assessment chapter in support of the reregistration eligibility decision on carbaryl. The chapter has been abridged from its April 8, 2002, version at the request of the Special Review and Reregistration Division and no longer includes environmental fate data evaluation records contained in the original chapter. Although the data evaluation records were cleared for confidential business information, their presence in the chapter did not contribute significantly to understanding the environmental fate of carbaryl. If interested, the public can access both environmental fate and ecological effect data evaluation records by petitioning the Agency through the Freedom of Information Act.

The revised chapter reflects comments made by the registrant (Aventis) during the 30-day error correction phase of the review process and contains more detailed information on the input files for the Pesticide Root Zone Model (PRZM) used in estimating runoff concentrations of carbaryl. Although the registrant provided constructive comments in their 30-day responses to the draft risk assessment of carbaryl, the overall concerns and uncertainties originally identified regarding the environmental fate and ecological effects of carbaryl have not changed.

Also included with the revised chapter is a review (DP Barcode D279109) of data submitted regarding the Section 24C Special Local Needs use of carbaryl on oyster beds in Willapa Bay and Grays Harbor, Washington, for control of burrowing shrimp.

Both the revised environmental fate and ecological effects chapter and the review of the use of carbaryl to control burrowing shrimp are intended to represent EFED's assessment of the risks associated with the uses of carbaryl. While some uses and application rates discussed in the chapter may no longer be supported, the EFED chapter is intended to provide a general overview of the concerns and uncertainties associated with the past and present uses of carbaryl.

Environmental Fate and Ecological Risk Assessment For the Reregistration of Carbaryl



1-Naphthyl methylcarbamate
1-naphthyl N-methylcarbamine
CAS Registry Number 63-25-2
PC Code 056801

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1.0 Summary and Environmental Risk Conclusions

Carbaryl is a carbamate insecticide registered for control of a wide range of insect and other arthropod pests on over 100 crop and noncrop use sites, including home and garden uses. Carbaryl is a cholinesterase inhibitor that acts on animals on contact and upon ingestion by competing for binding sites on the enzyme acetyl cholinesterase, thus preventing the breakdown of acetyl choline.

Risk to Terrestrial Organisms

- Three different kinds of usage data were considered to assess risk to terrestrial organisms: maximum label rates for 74 uses, maximum reported (based on survey usage data available from the Doane's Agricultural Services for 42 uses) rates, and Quantitative Usage Analysis "average" rates data provided by OPP's Biological and Economic Analysis Division for 70 uses. In most cases the Level of Concern (LOC) exceedance pattern was not significantly affected by the kind of application rate data used to calculate risk quotients.

- Although no avian acute risk LOCs are exceeded for any nongranular carbaryl uses at maximum or less than maximum label application rates, the avian chronic risk LOC is exceeded for most uses. The avian acute LOC is exceeded for 20 g birds for all granular carbaryl uses (risk quotients [RQs]: 0.52 - 4.76) and for 180 g birds, it is exceeded for the trees/ ornamentals, turfgrass, and tick control uses (RQ: 0.53). No acute LOCs are exceeded for birds in the 1000 g weight class for any of the granular carbaryl uses.

- At maximum label rates, the mammalian acute risk LOC (0.5) is exceeded for all 74 non-granular uses (0.76 - 12.12). The proportion of RQs exceeding the acute LOCs decreases significantly for mammals in all three weight classes feeding on fruits, pods, seeds, and large insects, as well as for the 1000 g mammals feeding on broadleaf/forage plants and small insects. At maximum reported application rates the acute risk LOC for 15 g mammals feeding on short grass is exceeded for 41 of 42 nongranular carbaryl uses (RQs: 0.60 - 11.36), and at "average" use rates is exceeded for 63 of 70 uses.

- The mammalian chronic risk LOC (1) is exceeded for practically all nongranular carbaryl uses at maximum label (RQs: 3.0 - 48.0), maximum reported (RQs: 1.5 - 45.0), and "average" use rates (RQs: 1.5 - 15.9). Therefore, almost all nongranular carbaryl uses are expected to pose acute and chronic risks to small mammals.

- At maximum label rates, acute risk LOCs are exceeded for 15 g mammals (RQs: 2.3 - 21.1) and 35 g mammals (RQs: 0.99 - 9.04) for all granular uses, indicating that all granular carbaryl uses pose an acute risk to the smaller mammalian species. For 1000 g mammals, the acute risk LOC is not exceeded for any use.

- Being highly toxic to honey bees and arthropods in general, carbaryl poses a risk to beneficial insects, including many pests's natural enemies, when directly exposed to carbaryl applications, residues on foliage, or contaminated pollen or nectar. Carbaryl is one of the pesticides more often implicated in bee mortality incidents, ranking second and third, respectively, in two separate bee kill surveys undertaken in 1997 by the Washington State Department of Agriculture and the American Beekeeping Federation.

Risk to Aquatic Organisms

- Three different application scenarios were considered in assessing risk to aquatic organisms: maximum label rates, maximum reported (based on survey usage data available for 42 uses) rates, and "average" rates. In most cases the Level of Concern (LOC) exceedance pattern was unaffected by the kind of usage data used to calculate risk quotients.

- The acute risk LOC (0.5) for freshwater fish is exceeded for one of five use scenarios modeled (citrus), at maximum label (RQ: 1.10), maximum reported (RQ: 0.93), and "average" (RQ: 0.58) use rates, while the chronic risk LOC for freshwater fish is not exceeded for any scenario, at any use rate.

- The acute risk LOC for estuarine/marine fish is not exceeded for any use scenario modeled, at any use rate. Because of lack of valid chronic toxicity data, it is not possible to fully assess chronic risk to estuarine/marine fish at this time.

- Available nonguideline studies suggest that exposure to carbaryl may act as a potential endocrine disruptor in fish. Exposure to sublethal carbaryl levels cause a significant reduction of serum and pituitary levels of gonadotropic hormone and gonadotropin- releasing hormone in the freshwater murrell and a significant decline in ovarian estrogen levels in freshwater perch, starting on day 15 of exposure.

- Most carbaryl uses are likely to pose an acute risk to both freshwater and estuarine/marine aquatic invertebrates, especially arthropods. The acute risk LOC (0.5) for freshwater invertebrates is exceeded for all five use scenarios modeled at maximum label (RQs: 5.1 - 161.2), maximum reported (RQs: 3.3 - 136.5), and "average" (RQs: 2.6 - 85.3) use rates. The chronic risk LOC (1) is also exceeded for freshwater invertebrates for all 5 use scenarios modeled, at maximum label (RQs: 3.3 - 91.3), maximum reported (RQs: 2.0 - 74.7), and "average" (RQs: 1.7 - 44.7) use rates.

- The acute risk LOC is exceeded for estuarine/marine invertebrates for the 5 use scenarios modeled at maximum label (RQs: 1.5 - 48.1), maximum reported (RQs: 1.0 - 40.7), and "average" (RQs: 0.8 - 25.4) use rates. Lack of reliable toxicity data precluded the assessment of chronic risk for estuarine/marine invertebrates.

- Carbaryl directly applied to oyster beds in Washington State poses a severe, albeit localized and temporary, acute risk to fish and nontarget arthropods in and around the target area. The oyster industry is encouraged to continue searching for alternative pest shrimp management measures and more selective carbaryl application regimes, within an IPM context, to minimize impact on non-target organisms.

Risk to Plants

- Carbaryl can be used as a fruit thinning agent on apples and pears, and according to the label it may cause injury to tender foliage if applied to wet foliage or during periods of high humidity. It may also cause injury to Boston ivy, Virginia creeper, or maidenhair fern. A few incidents involving injury to vegetable crops (potatoes, tomatoes, cabbage, and broccoli) have been reported. To fully assess carbaryl risk to terrestrial plants, Tier I and, if appropriate, Tier II Seed Germination and Seedling Emergence, as well as Vegetative Vigor studies should be submitted by the registrant.

- Based on the single core green alga study available, the acute risk LOC for aquatic plants is not exceeded for any of the five scenarios modeled even at maximum label rates. However, because four of the required five toxicity studies with aquatic plants are unavailable, these results are insufficient to fully assess carbaryl risk to aquatic plants. Toxicity testing for aquatic plants is required to support carbaryl's registered forestry uses.

Risk to Endangered Species

- The endangered species LOC for birds is met or exceeded for most nongranular carbaryl uses at maximum label, QUA average, and maximum reported use rates. The endangered species LOC is exceeded for 20 g birds for all granular uses; it is exceeded for 180 g birds it is exceeded for all granular uses, except cucumber, melons, pumpkin, squash, beans, peas, lentils, cowpeas, southern peas, wheat, millet, and sugar beets; and for 1000 g birds, it is reached for the trees and ornamentals, turfgrass, and tick control granular uses.

- The endangered species LOC for mammals is met or exceeded for all uses at maximum label, QUA average, and maximum reported use rates.

- At less than maximum label rates the endangered species LOC is exceeded for all carbaryl uses for freshwater and marine/estuarine aquatic invertebrates. At less than maximum label rates, the endangered species LOC is exceeded for freshwater fish only for the citrus use scenario and not exceeded for estuarine/marine fish for any of the five use scenarios modeled.

Fate and Water Assessment

- Carbaryl is widely detected in surface water at concentrations up to about 7 : g/L. In general observed concentrations are generally less then 0.5 : g/L. It was the second most widely detected insecticide, after diazinon, in the U.S. Geological Survey's National Water Quality Assessment (NAWQA) program. NAWQA reported that about 20 % of surface water samples had detectable carbaryl concentrations. For samples where carbaryl was detected the mean concentration was 0.11 : g/L and the maximum was 5.5 : g/L. Urban streams had higher frequency of detection then those draining agricultural areas, and had higher concentrations. A targeted study by the registrant found detectable levels of carbaryl in 9 of 15 sites in agricultural areas and 100% of 4 sites in suburban areas (limit of detection = 0.002 : g/L). Raw water samples from suburban sites had measured residues greater then the limit of detection but below the level of quantitation (0.03 : g/L) ranging from 0.002 to 0.023 : g/L. Concentrations in samples from agricultural sites were lower, with one sample measuring about 0.16 : g/L, one at 0.031 : g/L and the rest were below the level of quantitation. While this study was targeted at carbaryl use areas only 20 sites were sampled. It is not known how the selected sites relate to the overall distribution of possible exposures. The concentrations found in this study are similar to those reported n non-targeted studies. They are not the maximum that occur as evidenced by higher values found in non-targeted studies.

- Because of the relatively limited persistence of the compound in the environment it is unlikely that non-targeted monitoring studies will detect the maximum concentrations that occur. Extensive data from targeted studies designed specifically to measure carbaryl in relation to actual application and environmental occurrence is not available. Only the registrant study has tried to target use areas. This study, while useful, is limited in extent and did not measure the concentrations as high as observed in other, non-targeted studies. Because of the limited number of sites sampled and lack of information on how sampled sites relate to the overall carbaryl use area this study can not be used to estimate the distribution of expected environmental concentrations which actually occur. Targeted monitoring data is limited to this study which found concentrations below those observed in other studies. This lack of extensive targeted data and the limitations inherent in using non-targeted data to extrapolate to actual environmental concentrations indicate that computer modeling may provided a more representative estimate of actual peak concentrations that occur.

- Computer modeling using the EPA PRZM3.12 and EXAMS 2.97.5 programs were used to estimate the maximum and average concentrations of carbaryl in surface water. Estimated environmental concentrations (EECs) for use in human health risk assessment were developed by modeling with Index Reservoir scenarios corrected for Percent Cropped Area (PCA) for representative crops. Three different application rate scenarios were used in modeling: the maximum allowed on the label for the specific crop, an "average" rate, and the maximum rate reported to actually be used[1]. EECs varied greatly depending on the geographic location, crop and application rate. EEC values ranged from about 10 : g/L from sugar beets to about 500 : g/L from citrus. Chronic EECs ranged from about 1 to 28 : g/L. With the exception of Florida citrus the calculated EECs are 3-5 times as high as concentrations observed in monitoring data. It is highly unlikely that any but the most extensive targeted monitoring would capture the actual peak concentrations, and the results of the modeling provide an conservative, though not unreasonable, estimate of possible concentrations in drinking water.

- The maximum calculated EEC resulted from use on citrus in Florida. A more detailed assessment of the source of water used to provide drinking water and the relationship between the areas where carbaryl is used and surface water supply sources is required to more accurately evaluate possible human exposures. In 1995, seven percent of Florida's population (about one million people) relied on surface water for their drinking water needs (Marella, 1999). A subset of these people get their water from citrus areas. Until more accurate data on land use and related pesticide application is available and can be linked with data on the location and hydraulic characteristics of the water bodies used for water supply it is not possible to provide a more accurate assessment of possible exposures. Also, the Percent Crop Area for citrus may be much lower then the default minor use crop value of 87% so the corresponding concentration may be lower.

- Carbaryl and its degradate 1-naphthol are fairly mobile and slightly persistent. In general they are not likely to persist or accumulate in the environment. Under acidic conditions with limited microbial activity they may persist.

- Carbaryl dissipates in the environment by abiotic and microbially mediated degradation. The major degradation products are CO_2 and 1-naphthol, which is further degrade to CO_2. Carbaryl is stable to hydrolysis in acidic conditions, but hydrolyzes in neutral (half-life = 12 days) and alkaline environments (pH 9 half-life = 3.2 hours). Carbaryl is degraded by abiotic photolysis in water with a half-life of 21 days. Under aerobic conditions the compound degrades rapidly by microbial metabolism, with half-lives of 4 to 5 days in soil and aquatic environments. In anaerobic environments metabolism is much slower with half-lives on the order of 2 to3 months. Carbaryl is considered to be moderately mobile in the environment (K_f =1.7 to 3.5).

- The major metabolite of carbaryl degradation by abiotic and microbially mediated processes is 1-naphthol. This degradate represented up to 67% of the applied carbaryl in degradation

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[1] **Maximum** is the highest application rate allowed according to the label for the specific crop.

"Average" is the average rate as determined by OPP/BEAD and reported in the a memo titled Quantitative Usage Analysis for Carbaryl, prepared July 21, 1998 by Frank Hernandez, OPP/BEAD. These average rates are presented here, but are not relevant for drinking water exposure estimates as the usage is averaged over a geographic area. The values do not represent a typical rate that a user in a specific area applies.

Maximum used is the highest rate of application that is actually reported to be used based on OPP/BEAD analysis of DoaneS survey data.

studies. It is also formed in the environment by degradation of naphthalene and other polyaeromatic hydrocarbon compounds. Only limited information is available for the environmental transport and fate 1-naphthol. While guideline studies were not submitted specifically for the degradate, open literature information suggests that it is less persistent and less mobile than parent carbaryl.

- Monitoring data for carbaryl in groundwater suggest that carbaryl is not a major groundwater contaminant though targeted data is not available. Parent carbaryl is detected in about 1 % of well samples in non-targeted monitoring studies, generally at low concentrations (<0.1 : g/L). In the U.S.G.S NAWQA program detections in groundwater were mainly from three setting: wheat (5.8 % of well samples from wheat land use), orchards and vineyards (1.7 % of well samples from orchard and vineyard land use), and urban (1.8% of urban groundwater samples).

2.0 Introduction

Carbaryl (1-naphthyl N-methylcarbamate) is a broad-spectrum carbamate insecticide and acaricide registered for control of over 300 species of insects and mites on over 100 crop and noncrop use sites, including homeowner uses; pet, and poultry uses; and treatment of oyster beds. As other carbamates, carbaryl is a cholinesterase inhibitor that acts on animals on contact and upon ingestion by inactivating the enzyme acetylcholinesterase and blocking the degradation of the neurotransmitter acetylcholine. As a result, the build up of acetylcholine causes an over-stimulation of the central nervous system.

Introduced in 1956, carbaryl was the first carbamate insecticide to be successfully marketed for a wide range of agricultural and household lawn and garden uses. Approximately 2.5 million pounds of carbaryl are applied annually in the U.S. A map showing the widespread use of carbaryl in agriculture is shown in Figure 1.

Technical carbaryl is a white crystalline solid that has no appreciable odor. Carbaryl end-use formulations include aqueous dispersions, baits dusts, emulsifiable concentrates, flowables, granules, oil based flowables, powder, soluble concentrates, suspension concentrates, wettable powders, water based flowables, water dispersible granules, and ready-to use formulations. Carbaryl can be applied by aircraft, ground equipment, and sprinkler irrigation. The principal registrant is Aventis.

For the years of 1987-96, carbaryl usage averaged approximately 2.5 million pounds a.i. for over 1.5 million acres treated. Average estimates for major crops treated include alfalfa (120,000 acres), apples (131,000 acres), corn (82,000 acres), hay (91,000 acres), pecans (95,000 acres), soybeans (101,000 acres), and wheat (106,000 acres). Crops with a high percentage of the total planted acreage treated include Chinese cabbages (57%), asparagus (43%), cranberries (39%), Brussels sprouts (33%), okra (32%), pumpkins (31%), and sweet cherries (25%)[2]. Carbaryl is also used for residential and other non-agricultural uses, being the seventh most commonly used insecticide around the home.

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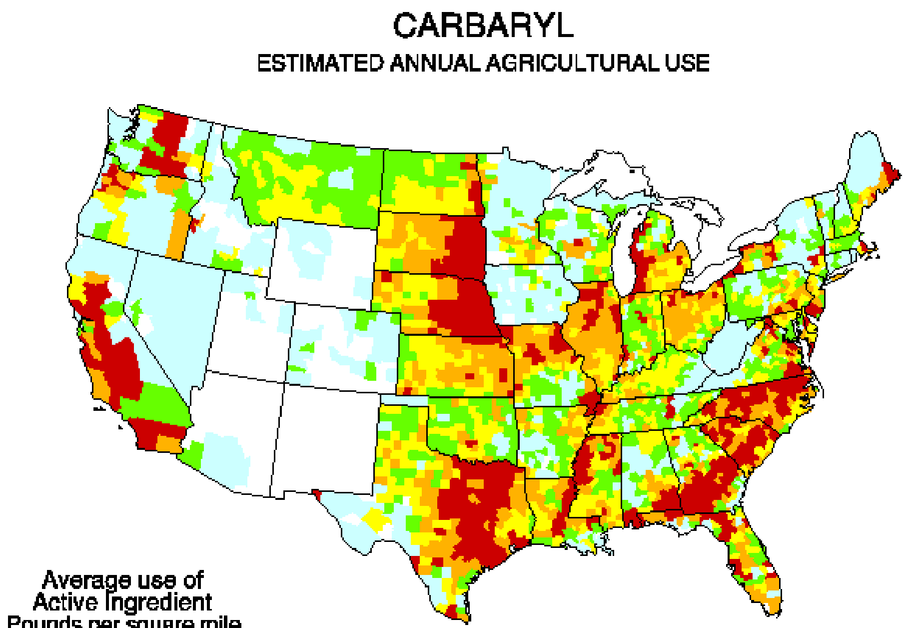
[2]Quantitative Usage Analysis for Carbaryl, OPP/BEAD, 1998

3.0 Integrated Risk Characterization

Introduction



Crops	Total Pounds Applied	Percent National Use
alfalfa hay	490, 173	10. 76
corn	427, 446	9. 39
pecans	423, 526	9. 30
other hay	358, 777	7. 88
all citrus	339, 934	7. 46
soybeans	336, 308	7. 38
apples	281, 131	6. 17
sorghum	260, 043	5. 71
grapes	200, 728	4. 41
peaches	146, 008	3. 21

Figure 1: Carbaryl use in Agriculture (Source USGS http://water.wr.usgs.gov/pnsp/use92/mapex.html)

Carbaryl is a widely used insecticide, and as a result of normal agricultural and non-agricultural uses, it is commonly detected in the environment. Carbaryl and its primary degradate 1-naphthol are fairly mobile and slightly persistent. In general they are not likely to persist or accumulate in the environment. Under acidic conditions with limited microbial activity they may persist. Carbaryl dissipates in the environment by abiotic and microbially mediated degradation. The major degradation products are CO_2 and 1-naphthol which is further degraded to CO_2. Carbaryl is stable to hydrolysis in acidic conditions but hydrolyzes in neutral (pH 7 half-life 12 days) and alkaline (pH 9 half-life = 5 hours environments. Carbaryl is degraded by photolysis in water with a half-life of 21 days. Under aerobic conditions the compound degrades rapidly by microbial metabolism with half-lives of 4 to 5 days in soil and aquatic environments. In anaerobic environments metabolism is much slower with half-lives on the order of 2 to3 months. Carbaryl is mobile in the environment (K_f =1.7 to 3.5).

The major metabolite of carbaryl degradation by abiotic and microbially mediated processes is 1-naphthol. Only limited information is available for the environmental transport and fate 1-naphthol. While guideline studies were not submitted specifically for the degradate open literature information suggests that it is less persistent and less mobile then parent carbaryl.

Carbaryl is commonly detected in surface water monitoring studies. Concentrations are generally low (less than 1 :g/L), and the maximum reported value is less than 10 :g/L. In groundwater carbaryl is detected less often and at lower levels (generally less than 0.01 :g/L). Because of the relatively limited persistence of the compound in the environment it is unlikely that non-targeted monitoring studies will detect the maximum concentrations that occur. Because only very limited targeted data of uncertain quality exists modeling was used to estimate maximum and average concentrations that may occur. Model results suggest that concentrations in surface water resulting from normal agricultural practices are high enough to adversely effect a variety of aquatic, estuarine and marine species.

Aquatic Organisms

Most carbaryl uses are not likely to pose acute or chronic risks to freshwater fish, nor an acute risk to estuarine/marine fish. Most carbaryl uses, however, are likely to pose acute and chronic risks to freshwater invertebrates, and acute risk to estuarine/marine invertebrates. On an acute basis, carbaryl is highly to slightly toxic to freshwater fish (LC_{50} = 0.25 - 20 ppm), moderately toxic to estuarine/marine fish (LC_{50} = 2.6 ppm), very highly toxic to freshwater aquatic invertebrates (LC_{50} = 1.7 - 26 ppb), and very highly toxic to estuarine/marine aquatic invertebrates, especially mysids.

Carbaryl's main degradate, 1-naphthol, is highly to moderately toxic to freshwater fish (LC_{50} = 0.75 - 1.6 ppm), moderately toxic to estuarine/marine fish (LC_{50} = 1.2 - 1.8 ppm), highly toxic to freshwater invertebrates (LC_{50} = 0.7 ppm), and highly toxic to moderately toxic to estuarine/marine invertebrates (0.21 - 2.5 ppm). EECs for 1-naphthol can not be calculated because of a lack of fate and transport data.

Exposure to sublethal carbaryl levels in laboratory studies are known to adversely affect survival of freshwater fish young (NOAEC = 0.25 ppm) and reproduction in freshwater invertebrates (NOAEC = 3.3 ppb). NOAEC values for estuarine/marine fish and invertebrates have not been established because of missing data on chronic toxicity to estuarine/marine fish.

Although EEC scenarios for aquatic organisms were modeled using three different kinds of application rate data (maximum label, maximum reported Doane, and "average" rates), the LOC exceedances are minimally affected by the type of usage data. The acute risk LOC for freshwater fish is exceeded for one of five use scenarios modeled (citrus) at all three application rates, and the chronic risk LOC is not exceeded for any scenario, at any use rate (Table 1).

Exposure to certain sublethal carbaryl concentrations can produce deleterious effects in freshwater fish. When the freshwater murrell (*Channa punctatus*) is exposed to concentrations in the 1666 - 3730 ppb range, the resulting inhibition of acetycholinesterase (AChE) can cause thyroid and gonadal dysfunction (Ghosh et al., 1990). However, this study was performed at concentration levels well above the highest peak concentration modeled for carbaryl (Table 5) and, therefore, does not provide an indication as to potential effects under field conditions. In the fathead minnow (*Primephales promelas*), exposure to concentrations in the 0.008 - 0.68 mg/l (8 - 680 ppb) prevented reproduction and decreased survival only at the highest test concentration (Carlson 1972). The NOAEC determined by this study, 0.21 mg/l (210 ppb), is at the high end of the peak EECs predicted from models for only the citrus scenario (Table 5) and well below the peak EECs predicted for the other four scenarios that were modeled

Table 1.Aquatic organisms: acute and chronic Risk LOC exceedances and RQs for nongranular carbaryl uses

		Acute Risk			Chronic Risk		
		Label Max	Max Rep	"Average"	Label Max	Max Rep	"Average"
Freshwater Fish	LOC Exceed.[1]	1/5	1/5	1/5	0/5	0/5	0/5
	RQs	1.1	0.93	0.58	---	---	---
Estuarine/ Marine Fish	LOC Exceed.[1]	0/5	0/5	0/5	no data	no data	no data
	RQs	---	---	---			
Freshwater Inverts	LOC Exceed.[1]	5/5	5/5	5/5	5/5	5/5	5/5
	RQ Ranges	1.5-48.9	1.1-4	0.8-25.9	3.3-91.3	2.0-74.7	1.7-44.7
Estuarine/ marine Inverts	LOC Exceed.[1]	5/5	5/5	5/5	no data	no data	no data
	RQ Ranges	1.5-48.1	1.0-40.7	0.8-25.4			

[1]No. use scenarios for which RQ is greater than LOC/total No. use scenarios examined (acute LOC = 0.5, chronic LOC = 1)

At relatively high concentrations, carbaryl can adversely affect amphibians' development and behavior. For instance, Bridges (2000) reports that acute exposure to carbaryl in southern leopard frogs during development, from egg to tadpole, results in a higher rate of deformities relative to control tadpoles. Nearly 18% of the tadpoles exhibited some type of developmental deformity, including both visceral and limb malformities, compared to a single deformed (less than 1%) control tadpole. Activity of plains leopard frog tadpoles exposed to carbaryl diminishes by nearly 90% at 3.5 mg/L and ceases completely at 7.2 mg/L (Bridges, 1997). Although under the reported test conditions potential consequences of reduced activity and swimming performance can lead to increased vulnerability to predation, slower growth, and failure to complete metamorphosis, tests concentrations are considerably higher than the highest surface water EECs calculated for carbaryl. Testing at or below maximum EEC is needed to better understand if amphibians are indeed likely to be at risk when exposed to carbaryl at concentrations likely to occur under field conditions. It is also possible that the PRZM/EXAMS pond modeling may not be conservative enough for amphibians breeding in temporary pools and other short-lived aquatic habitats exposed to carbaryl through runoff and/or spray drift.   EFED is concerned about the behavioral and developmental effects of carbaryl on amphibians; when appropriate test procedures have been developed to examine these effects, EFED will request that carbaryl undergo these studies.

The acute risk LOC for estuarine/marine fish is not exceeded for any use scenario modeled, at any use rate, indicating that, except for the oyster bed use in Washington State, carbaryl uses are unlikely to pose an acute risk to these organisms. The absence of core chronic toxicity data precluded the calculation of an RQ for estuarine/marine fish. Information from the open literature, however, indicates that exposure to sublethal levels of carbaryl can produce certain adverse effects in some species. According to Weis and Weis (1974), laboratory exposure of the silverside (*Menidia menidia*) to a single dose of carbaryl (100 ppb) resulted in the temporary disruption of schooling behavior, consisting mainly of a spreading out of the school over a larger area. This change in behavior was observed after 24 h exposure. Returning the fish to carbaryl-free water did not bring about a return of normal schooling patterns until 72 hours. This effect was attributed to the accumulation of carbaryl degradate1-naphthol.

Aerial carbaryl applications to tideland areas in Washington State, at 7.5 - 8 lb ai/acre, for control of burrowing shrimp in commercial oyster beds are known to pose a significant acute risk to fish inhabiting treated mudflats or trapped in shallow pools. Estimates of potential fish kills range from 15,000 to 96,000 following each treatment (MRID 419826-06). Exposure to sublethal carbaryl levels may also inhibit acetylcholinesterase in fish in subtidal areas near treated sites, resulting in a temporary impairment of burying behavior and increasing exposure to predators (Pozorycki, 1999). Along with the burrowing shrimp, other invertebrate populations inhabiting treated mudflats, which constitute a food source for fish, are temporarily reduced or eliminated. There may be up to 100% mortality of Dungenese crab populations following carbaryl applications. However, some invertebrates recolonize the treated areas within two weeks (MRID 419826-06), and most populations of invertebrates recover in less than two months (Brooks 1993). Once established, the oyster beds provide a suitable environment for a species-diverse community, as many plants and invertebrates, which are normally rare or absent in barren mudflats, readily grow on or in between oyster shells (MRID 419826-06). Since, on average, tideland areas are treated once every six years, adverse effects on the aquatic biota are temporary. Potential nonchemical pest management methods identified include alternative culture techniques, mechanical control, enhancement of shrimp predators, and electrofishing. Carbaryl application techniques that reduce drift, such as direct injection of carbaryl into the sediment, should be also further explored. In addition, improvements in the forecasting of shrimp infestation and the refinement of current action thresholds may help to decrease the frequency and amount of carbaryl applications without affecting effectiveness.

Environmental concentrations of carbaryl resulting from normal agricultural uses have been shown to have effects on invertebrate populations and individuals. Both acute and chronic risk LOCs are exceeded for freshwater invertebrates for all five carbaryl aquatic use scenarios modeled at maximum label, maximum reported, and "average" use rates, indicating that most carbaryl uses are likely to pose acute and chronic risks to freshwater invertebrates. Emergence of aquatic insects, such as damselflies, can also be severely reduced after 10 -12 days exposure to 100 µg/L of carbaryl (Hardersen and Wratten, 1998). In a mesocosm study, at carbaryl concentrations above 20 µg/L

Daphnia were no longer found and at concentrations greater than 50 µg/L, all cladocerans were eliminated, resulting in increased algal biomass due to repartitioning of biomass from zooplankton to phytoplankton (Havens, 1995). Studies with the freshwater snail (*Pomaca patula*) have shown that increased acetyl cholinesterase (AChE) inhibition occurs concurrently with the bioconcentration of carbaryl after 72 hour exposure at 3.2 µg/g (Mora *et al.*, 2000).

The acute LOC for estuarine/marine invertebrates is exceeded for all five carbaryl use scenarios assessed at maximum label, maximum reported, and "average" application rates, indicating that estuarine/marine invertebrates inhabiting intertidal zones and estuaries near areas where carbaryl is applied are likely to be at risk.

Terrestrial Organisms

Three different kinds of nongranular carbaryl usage data were considered for assessing risk to terrestrial animals: maximum label rates, maximum reported (Doane data available for 42 uses) rates, and QUA "average" rates. In most cases the LOC exceedance pattern was not significantly affected by the kind of usage data used to calculate risk quotients.

Acute risk quotients indicate that, although none of nongranular carbaryl uses may pose an acute risk to birds, all nongranular uses present a chronic risk to birds. All granular uses are likely to pose an acute risk to 20 g birds, and all granular uses, except for cucurbits, legumes, wheat, millet, and sugar beet, also represent a risk to 180 g birds, while only the trees and ornamentals, turfgrass, and tick control uses pose a risk to 1000 birds.

All nongranular and granular uses are likely to pose an acute risk to 15 g and 35 g mammals. All nongranular uses pose a chronic risk to mammals. Table 2 summarizes LOC exceedances as well as the respective RQ ranges for nongranular uses.

The Agency is aware of only a few carbaryl-related mortality incidents for mammals and birds, all involving small numbers of individuals. Although few in number and magnitude, considering that few mortality incidents are actually detected and reported, these known incidents suggest that a certain level of acute risk to birds and mammals from exposure to carbaryl does exist under field conditions.

Table 2. Avian and Mammalian Acute and Chronic Risk LOC Exceedances and highest RQs for Nongranular Carbaryl Uses at Maximum Label, Maximum Reported, and QUA Average application rates.							
		Acute Risk			Chronic Risk		
		Label Max	Max Rep	"Average"	Label Max	Max Rep	"Average"
Birds	LOC Exceed.[1]	0/74	0/42	0/70	73/74	34/42	39/70
	RQs	N/A	N/A	N/A	1.5-12.8	1.0-12.0	1.0-4.2
Mammals	LOC Exceed.[1]	74/74	41/42	63/70	72/74	42/42	69/70
	RQs	0.76-12.12	0.60-11.36	0.53-4.02	3.0-48.0	1.5-45.0	1.5-15.9

[1] No. uses for which the highest RQ is greater than LOC/total No. uses examined (acute LOC for birds = 1; acute LOC for mammals = 0.5, chronic LOC for birds and mammals = 1)

Based on a rock dove LD_{50} of 1,000 mg/kg and a mallard LD_{50} greater than 2,000 mg/kg, technical carbaryl can be classified as slightly to practically nontoxic to birds on an acute basis. LD_{50} values for carbaryl as low as 16.2 mg/kg and 56.2 mg/kg have been reported for the starling and the red-winged blackbird, respectively (Schafer et al., 1983). Although these data are based on simple screening tests, and are therefore not reliable for risk assessment purposes, they do suggest that passerine birds may be significantly more sensitive to carbaryl exposure than non-passerine birds. Thus, the registrant is strongly encouraged to submit acute oral toxicity tests with passerine avian species. This risk assessment is using the dove LD_{50} (lower 95% confidence interval = 1,000 mg/kg) to calculate acute RQs for granular carbaryl.

On a subacute, dietary basis, carbaryl is practically nontoxic to birds. The quail LC_{50} is greater than 5,000 ppm, and an LC_{50} greater than 10,000 ppm is reported for the Japanese quail (*Coturnix*) by Hill and Camardese (1986). On a chronic basis, the NOAEC is 300 ppm for the mallard duck, based on adverse reproduction effects including reduced egg production, decreased fertility, and increased incidence of cracked eggs. For this risk assessment, the quail LC_{50} (> 5,000 ppm) and the duck NOAEC (300 ppm) are used to calculate the subacute dietary and chronic RQs, respectively.

The avian acute risk level of concern (LOC) is not exceeded for any nongranular carbaryl use, at maximum or less than maximum label application rates. The avian chronic risk LOC is exceeded for almost all (73 of 74) uses considered at maximum label rates, for 34 of 42 uses at maximum reported rates, and for39of 70 uses at "average" rates. The avian acute LOC is exceeded for 20 g birds for all granular carbaryl uses (RQs: 0.52 - 4.76). For 180 g birds, the acute LOC is exceeded for the trees/ornamentals, turfgrass, and tick control uses (RQ: 0.53). No acute LOCs are exceeded for birds in the 1000 g weight class for any of the granular carbaryl uses.

Carbaryl is moderately toxic to small mammals on an acute oral basis (rat LD_{50} = 301 mg/kg) and, based on decreased fetal body weights and increased incomplete ossification of multiple bones in the laboratory rat (LOAEC = 600 ppm, NOAEC = 80 ppm), has the potential for mammalian chronic effects.

As summarized in Table 2, at maximum label rates the mammalian acute LOC is exceeded for all 74 nongranular carbaryl uses, and the chronic risk LOC is exceeded for 70 of the uses. RQs based on maximum reported rates for 42 uses exceed the acute LOC for 41 uses, while the chronic risk LOC is exceeded for all 42 uses. When "average" rates are used to calculate RQs for 70 nongranular uses, the acute risk LOC is exceeded for 63 uses, and the chronic risk LOC is exceeded for 69 uses, indicating that LOC exceedances are minimally affected when mammalian RQs are calculated using less than maximum label rates.

Information available in the open literature suggests potential reproduction effects of carbaryl on mammals. Several field and laboratory studies report significant reproduction effects for several species of mammals, including reduced reproduction, disturbances in spermatogenesis, pathological pregnancy, increased embryonal resorption, increased percentages of infertile females, and males with underdeveloped testicles (Gladenko *et al.,* 1970, Smirnov *et al.,* 1971, Krylova *et al.,* 1975, Pomeroy & Barrett, 1975). Others report only slight effects (Anonymous, 1969, Dougherty *et al.,* 1971, Narotsky and Kavlock, 1995). Some fail to detect any reproduction effects (DeNorscia and Lodge, 1973, Dougherty, 1975, Chapin *et al.,* 1997).

Carbaryl is highly toxic to honey bees (LC_{50} = 1.3 - 2.0 μg/ bee), and moderately to highly toxic to a wide range of other beneficial insects, including species that prey on or parasitize many insect pests. Carbaryl has been linked to numerous bee mortality incidents in several states, which is not surprising given its effectiveness as a broad-spectrum insecticide and its large number of uses. According to surveys conducted by the American Beekeeping Federation and the Washington State Department of Agriculture, carbaryl is one of the pesticides most frequently mentioned as being associated with bee kills (Brandi 1997, Johansen 1997). To minimize risk to bees and other pollinators, all carbaryl-containing products display the standard pollinator protection language in their labels.

As indicated by precautionary label language, carbaryl can cause injury to some terrestrial plants. Carbaryl, used as a fruit thinning agent on apples and pears, may cause fruit deformity under certain environmental conditions, and injury to tender foliage if applied to wet foliage or during periods of high humidity. As indicated in the label, carbaryl may also cause injury to Boston ivy, Virginia creeper, maidenhair fern, and Virginia and sand pines. A few incidents involving carbaryl injury to vegetable crops have been reported. To date, no terrestrial plant toxicity studies have been submitted to the Agency. To fully assess carbaryl risk to terrestrial plants, Tier I and, if appropriate, Tier II Seed Germination and Seedling Emergence, as well as Vegetative Vigor studies should be submitted by the registrant.

Endangered Species

The endangered species LOC for birds (0.1) is met or exceeded for 72 of 74 nongranular carbaryl uses at maximum label use rates, for 18 of 70 carbaryl uses at QUA average use rates, and for 25 of 42 maximum reported use rates. The endangered species LOC is exceeded for 20 g birds for all granular uses. For 180 g birds it is exceeded for all granular uses, except cucumber, melons, pumpkin, squash, beans, peas, lentils, cowpeas, southern peas, wheat, millet, and sugar beets. For 1000 g birds, the endangered species LOC is reached for the trees and ornamentals, turfgrass, and tick control granular uses.

The mammalian endangered species LOC for all three mammal weight categories and the grass/broadleaf plants/small insects food items is exceeded for all nongranular uses examined, at maximum label rates. At "average" and maximum reported use rates, the endangered species LOC for 15 g mammals feeding on short grass is exceeded for all carbaryl uses. The endangered species LOC is exceeded for 15 - 35 g mammals for all granular uses.

The endangered species LOC for freshwater fish is exceeded for three (sweet corn, field corn, and citrus) of five use scenarios modeled and for the citrus scenario at less than maximum label rates. For marine/estuarine fish, the endangered species LOC is met for the citrus scenario only at maximum label rates. The endangered species LOC is exceeded for freshwater and marine/estuarine aquatic invertebrates for all five use scenarios at maximum and less than maximum label use rates.

The uses of carbaryl on field crops (corn, soybeans, sorghum, wheat), forests and pasture/ rangeland were addressed by the US Fish and Wildlife Service (USFWS) in the reinitiation of consultation in September 1989. In their 1989 Biological Opinion, USFWS found jeopardy to a total of 86 species - 6 amphibians, 47 freshwater fish, 27 freshwater mussels, and 5 aquatic crustaceans. Reasonable and Prudent Alternatives (RPA) were given for each jeopardized species. Reasonable and Prudent Measures (RPM) were given for 18 non-jeopardized species to minimize incidental take of these species.

Many additional species, especially aquatic species, have been federally listed as endangered/threatened since the Biological Opinion of 1989 was written, and determination of jeopardy to these species has not been assessed for carbaryl. In addition, endangered insects, birds and mammals were not considered in the 1989 opinion and need to be addressed. Finally, not only are more refined methods to define ecological risks of pesticides being used but also new data, such as that for spray drift, are now available that were not existent in 1989. The RPAs and RPMs in the 1989 Biological Opinion may need to be reassessed and modified based on these new approaches. This can occur once the program is finalized and in place.

Endocrine Disruption Concerns

EPA is required under the Federal Food, Drugs, and Cosmetics Act (FFDCA), as amended by Food Quality Protection Act (FQPA), to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen- and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, carbaryl may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption.

There are data indicating that carbaryl has the potential for endocrine disruption effects on fish. Serum and pituitary levels of gonadotropic hormone and gonadotropin-releasing hormone (GnRH) in the freshwater murrell (*Channa punctatus*) are reduced by exposure to 1.66 - 3.73 ppm of carbaryl in laboratory and paddy field tests (Ghosh *et al*., 1990). The decrease in GnRH levels could be explained by exposure to high estrogen levels, acting through a negative feedback pathway to inhibit GnRH release, and thus the release of gonadotropins (Klotz *et al*., 1997). Plasma and ovarian estrogen levels in freshwater perch (*Anabas testudineus*) exposed to 1.66 ppm of carbaryl for 90 days increase until day 15 and then decline, relative to control fish, indicating that long-term exposure to this chemical may cause an inhibitory effect on fish reproduction (Choudhury *et al.,* 1993). Both the murrell and the perch studies, however, were performed at concentrations well above the highest peak concentration modeled for carbaryl and, therefore, may not reflect risk under field conditions.

Furthermore, a number of field and laboratory studies report reproduction effects with mammals, suggesting that the possibility of endocrine disruption effects on wild mammals should be further examined.

Uncertainties

The absence of valid chronic toxicity data for estuarine/marine fish, estuarine/marine invertebrates, and amphibians, as well as the lack of toxicity data for aquatic and terrestrial plants represent uncertainties in the risk assessment for carbaryl that need to be addressed through the submission of additional required data. Additionally, mammalian chronic RQs were based on a rat prenatal development study NOAEC (MRID# 44732901) rather than the more traditional use of a 2-generation reproduction study. Field studies suggest that exposure to a single carbaryl application may affect reproduction in small mammals.

Only very limited information is available for the environmental fate and transport of the major carbaryl degradate 1-Naphthol. Without additional data it is not possible to develop an fate profile for 1-Naphthol. Concentrations in surface and groundwater can not be estimated without data on the stability and mobility of the degradate compound.

4.0 Environmental Fate Assessment

Exposure Characterization

Using acceptable and supplemental environmental fate studies submitted by the registrant, along with published scientific literature, a profile of the fate and transport of carbaryl in the environment has been compiled. This information is sufficiently complete to allow the evaluation of the movement and fate of the compound. However, existing data gaps in Soil Photolysis, Terrestrial Field Dissipation, Aquatic Field Dissipation and degradate fate and mobility need to be addressed by the registrant.

Carbaryl dissipates in the soil environment by abiotic and microbially mediated degradation. The major degradation products are CO_2 and 1-naphthol, which is further degraded to CO_2. Carbaryl is stable to hydrolysis in acidic conditions, but hydrolyzes rapidly in alkaline environments. Carbaryl is degraded by photolysis in water, with a half-life of 21 days. Under aerobic conditions the compound degrades rapidly by microbial metabolism with half-lives of 4 to 5 days in soil and aquatic environments. In anaerobic environments metabolism is much slower with half-lives on the order of 2 to3 months. Carbaryl is mobile in the environment (K_f =1.7 to 3.5). Sorption onto soils is positively correlated with soil organic content, increasing with higher soil organic content. Table 3 summarizes the environmental fate characteristics of carbaryl. An analysis of the significance of the data is presented in this section.

Monitoring data for carbaryl in surface water and groundwater show that it is commonly found in surface water and groundwater. In surface water concentrations are generally low (less than 1 :g/L) and the maximum reported value is less than 10 :g/L. In groundwater carbaryl is detected less often and at lower levels (generally less than 0.01 :/L). Available monitoring studies and data sets are described below.

Because of the relatively limited persistence of the compound in the environment it is unlikely that non-targeted monitoring studies will detect the maximum concentrations that occur. Because of the limited amount of data available and because of potential problems with extant data (described below) monitoring data are of limited utility in developing EECs for ecological and human health risk assessment. Therefore, EFED used computer modeling to estimate surface water and groundwater concentrations that could be expected from normal agricultural use. For developing surface water EECs EFED used EPA PRZM3.12 and EXAMS 2.97.5 programs to estimate the concentration of carbaryl in surface water. For ecological risk assessment the standard pond scenario was used. For human health risk assessment index reservoir scenarios were used.

Several application rates were used in modeling: the maximum allowed for the specific crop, an "average" rate[3], and the maximum rate reported to actually be used[4]. The maximum rate was taken from the carbaryl labels. "Average and maximum reported rates were determined by EPA/BEAD based on data collected by Doane surveys and registrant market analysis. EECs varied greatly depending on the geographic location, crop, and application rate. Modeling "average" and maximum reported use rates yielded EEC values generally 40-60% lower than maximum. EFED normally uses the maximum allowed application rates in modeling. In this assessment other, "less then maximum", rates were modeled in order to evaluate how conservative maximum rates modeling estimates are. The average and maximum rates may or may not be representative of actual use rates and are of limited certainty due to the quality and extent of the data available to calculate them. As described in the BEAD chapter the average application rates were derived by dividing total pounds used by the overall use area. The resulting average does not represent the actual average applied to any specific area and is not relevant for fist assessment. The maximum reported rate was determined from DOANES survey results. These data, while the best available, are very limited. The number of farmers surveyed is small, often only one or two per state, and the statistical validity of the results are not known but it is highly unlikely that the survey identified the actual maximum value.

The maximum calculated EEC resulted from use on citrus in Florida. For the Index Reservoir scenario using maximum label rates, acute EEC values ranged from about 19 : g/L from sugar beets to about 500 : g/L from citrus (Table 6). Chronic EECs ranged from about 2 to 28 : g/L. These values are higher then concentrations observed in monitoring studies and probably represent conservative estimates of environmental concentrations. Modeling results are higher then monitoring data because of the limited persistence of the compound in most surface waters. It is highly unlikely that any but the most extensive targeted monitoring would capture the actual peak concentrations. The results of the modeling provide a conservative, though not unreasonable, estimate of possible concentrations in drinking water. A more detailed assessment of the source of water used to provide drinking water and the relationship between the areas where carbaryl is used and surface water sources is required to more accurately evaluate possible human exposures. Until more accurate data on land use and related pesticide application is available and can by linked with data on the location and hydraulic characteristics of the water bodies it is not possible to provide more accurate assessment of possible exposures. A more detailed description of modeling is presented below, and model input files are attached in appendix F.

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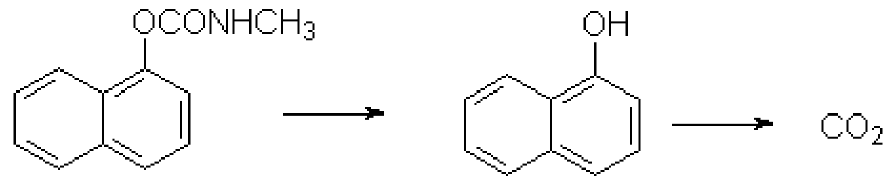
3 **"Average"** is the average rate as determined by OPP/BEAD and reported in the a memo titled Quantitative Usage Analysis for Carbaryl, prepared July 21, 1998 by Frank Hernandez, OPP/BEAD.

4 **Maximum used** is the highest rate of application that is actually reported to be used based on OPP/BEAD analysis of DoaneS survey data by Donald Atwood, Personal communication, January 31, 2001.



Carbaryl 1-naphthol Carbon dioxide

Figure 2. Generalized carbaryl degradation pathway

Table 3: Summary of Environmental Chemistry and Fate Parameters For Carbaryl (See Text for Analysis)

Parameter	***Value***	***Reference***
	Selected Physical/Chemical Parameters	
Molecular Weight	*201.22*	
Water Solubility	*32 mg/L (ppm) at 20° C*	*Suntio, et al., 1988*
Vapor pressure	*1.36* 10^{-7} *mm Hg (25° C)*	*Ferrira and Seiber, 1981*
Henry's Law Constant	*1.28 x* 10^{-8} *atm* m^3 mol^{-1}	*Suntio, et al., 1988*
Octanol/Water Partition	K_{ow} *= 229*	*Windholz et al., 1976*
	Persistence	
Hydrolysis $t_{1/2}$ *pH 5*	*stable*	*MRID 00163847, 44759301*
pH 7	*12 days*	
pH 9	*3.2 hours*	
Photolysis $t_{1/2}$ *aqueous*	*21 days*	*MRID 41982603*
Soil photolysis	*assumed stable*	*No valid data submitted*
Soil metabolism T½		
Aerobic	*4 days in one sandy loam soil*	*MRID 42785101*
Anaerobic	$t_{1/2}$ *= 72 days*	*Satisfied by 162-3*
Aquatic metabolism		
Aerobic	$t_{1/2}$ *= 4.9 days*	*MRID 43143401*
Anaerobic	$t_{1/2}$ *= 72 days*	*MRID 42785102*

Table 3: Summary of Environmental Chemistry and Fate Parameters For Carbaryl (See Text for Analysis)		
Parameter	***Value***	***Reference***

Major Transformation Products Identified in the Fate Studies:

***1-naphthol**, CO_2*

Minor Transformation Products Identified in the Fate Studies:

5-hydroxy-l-naphthyl methylcarbamate (aerobic soil metabolism, anaerobic aquatic)
1-naphthyl(hydroxymethyl)carbamate (aerobic soil metabolism, anaerobic aquatic)
1,4-naphthoquinone (aerobic aquatic metabolism, anaerobic aquatic)
(hydroxy)naphthoquinones (degradates of 1-naphthol)
4-hydroxy-1-naphthyl methylcarbamate (anaerobic aquatic)
1,5-naphthalenediol (anaerobic aquatic)
1,4-naphthalenediol (anaerobic aquatic)

	Mobility/Adsorption-Desorption	
Batch Equilibrium	*K_f (K_{oc}) =1.74 (207) - sandy loam 2.04 (249) - clay loam sediment 3.00 (211) - silt loam 3.52 (177) - silty clay loam 1/n values ranged from 0.78-0.84*	*MRID 43259301*
Column Leaching	*slightly mobile in columns (30-cm length) of sandy loam, silty clay loam, silt loam, and loamy sand soils*	*MRID 433207-01*
	Field Dissipation	
Terrestrial Dissipation	Submitted study not acceptable	MRID 419826-05
Forestry Dissipation	Foliar *$t_{1/2}$ = 21 days* *Leaf Litter $t_{1/2}$ = 75 days* Soil *$t_{1/2}$ = 65 days*	MRID 43439801
Aquatic	Submitted study not acceptable	MRID 4326001
Foliar Dissipation	30 days	Default value
	Bioaccumulation	
Accumulation in Fish	not expected due to low K_{ow}	

Persistence

Chemical Degradation Processes

Hydrolysis

Carbaryl hydrolysis is strongly pH dependant. The compound is stable under acidic conditions and degrades in neutral and alkaline systems with measured half-lives of 12 days (pH 7) and 3.2 hours (pH 9). Only one major degradate was identified, 1-naphthol (MRID 44759301). Chapman and Cole (1982) measured half-lives of 2.0 weeks (pH = 7.0) and 0.07 weeks (pH = 8). Wolfe *et al*. (1978) reported half-life values in natural pond waters at pH 6.7 of 30 days and at pH 7.2 of 12 days. They also estimated minimum hydrolysis half-life in acidic conditions of 1600 days. Armbrust and Crosby (1991) reported hydrolysis half-lives in filtered seawater of 24 hours at pH 7.9 and 23 hours at pH 8.3. The major degradation product was 1-naphthol which was stable to further hydrolysis.

Photolysis

Aqueous Photolysis

In an aqueous photolysis study, carbaryl, with an initial concentration of 10.1 mg/L, degraded in a pH 5 solution with a half-life of 21 days after correction for dark controls(MRID 41982603). The only degradate identified was 1-naphthol. Wolfe *et al.* (1978) reported a photolysis half-life in distilled water at pH 5.5 of 45 hours. In filtered seawater carbaryl degraded rapidly to 1-naphthol under artificial sunlight (290-360 nm) with a half-life of 5 hours. The degradation product, 1-naphthol, was degraded very rapidly with half-life of less than 1 hour (Armbrust and Crosby, 1991).

Soil Photolysis

A study of photolysis (MRID 41982604) on soil was submitted; however the study was determined to be invalid. No data on the possible soil photolysis of carbaryl is available. In view of this data gap, it is assumed that the compound is stable to photolysis on soil.

Microbially-mediated Processes

Carbaryl is degraded fairly rapidly by microbial processes under aerobic conditions and more slowly under anaerobic conditions. In a guideline study of aerobic soil metabolism carbaryl, with an initial concentration of 11.2 mg/kg, degraded with a half-life of 4.0 days in sandy loam soil incubated in the dark at 25^{B}C (MRID 42785101). The major degradate was 1-naphthol which further degraded rapidly to non-detectable levels within 14 days. In an aerobic aquatic metabolism study carbaryl, with an initial concentration of 9.97 mg/L, degraded with a half-life of 4.9 days in flooded clay loam sediment in the dark at 25° C (MRID 43143401). 1-Naphthol was identified as a major nonvolatile degradate. Carbaryl degraded with a half-life of 72.2 days in anaerobic aquatic sediment with an initial carbaryl concentration of about 10 mg/L; 1-naphthol was the major degradate. Minor degradates included 5-hydroxy-1-naphthyl methylcarbamate, 4-hydroxy-1-naphthyl methylcarbamate, 1,5-naphthalenediol, 1,4-naphthalenediol, 1-naphthyl(hydroxymethyl)carbamate, and 1,4-naphthoquinone

Liu, *et al.* (1981) studied carbaryl degradation in anaerobic and aerobic fermenters spiked with a mixture of lake sediment, silt loam and domestic activated sludge and buffered to pH 6.8. They reported abiotic degradation half-lives of 8.3 (aerobic) and 15.3 (anaerobic) days. After correcting for abiotic controls, when carbaryl was used as the sole carbon source they found aerobic and anaerobic metabolism half-lives of 54 and 11.6 days, respectively. When glucose and peptone were added co-metabolism aerobic and anaerobic metabolism, half-lives were 7.6 and 6.1 days respectively.

A number of soil microorgamisms have been identified which can degrade carbaryl including *Pseudomonas* sp (Chapalmadugu and Chaudhry, 1991; Larken and Day, 1986), *Rhodoccus* sp. (Larkken and Day, 1986), *Bacillus* sp. (Rajagopal. *et al.*,1984), *Arthrobacter* sp. (Hayatsu *et al.*, 1999), and *Achromobacter* sp (Karns *et al.*, 1986). Some bacteria are capable of complete degradation to CO_2 (Chapalamadugu and Chaudhry, 1991) while some stop at 1-naphthol. In soils it appears that consortia of bacteria are able to degrade parent and 1-naphthol completely to CO_2. Proposed degradation pathways proceed by using the methylcarbarmate side chain as a carbon source, converting the parent to 1-naphthol. 1-naphthol is then degraded through intermediates salicylaldehyde, salicylic acid, catechol, and gentisate to CO_2 and water (Chapalamadugu and Chaudhry, 1991; Hayatsu *et al.*, 1999). Several studies have shown that bacteria isolated from soil exposed to carbofuran can degrade carbaryl indicating cross adaption by microorganisms allowing degradation of compounds with similar structure (Karns *et al.*, 1986: Chaudhry, *et al.*, 1988). Carbaryl degradation utilizes enzyme systems which may or may not degrade other carbarmate compounds (Chapalamadugu and Chaudhry, 1991).

Mobility

Carbaryl is considered to be moderately mobile in soils. Based on batch sorption/ desorption studies, the compound has Freundlich K_f values of $\leq$3.52. Sorption is dependant on the soil organic matter content and increased with increasing K_{oc}.

Batch Adsorption/Desorption

Based on batch equilibrium experiments (*MRID* 43259301) carbaryl was determined to be moderately mobile to mobile in soils. In silty clay loam, sandy loam, loamy sand, and silt loam soils and clay loam sediment, mobility decreased with increasing soil organic matter content. Adsorption K_{oc} values ranged from 177-249. K_f values were 1.74 for the sandy loam soil, 2.04 for the clay loam sediment, 3.00 for the silt loam soil, and 3.52 for the silty clay loam soil. Corresponding K_{oc} values were 207, 249, 211, and 177, respectively, and 1/n values ranged from 0.78-0.84. Mobility decreased with increasing soil organic matter content. Sorption showed significant hystereses with Freundlich desorption constants ($K_{f(des)}$) values of 6.72 for sandy loam soil, 6.78 for clay loam sediment, 6.89 for silt loam soil, and 7.66 for silty clay loam soil. 1/n values ranged from 0.86-1.02. Corresponding desorption K_{oc} values were 800, 827, 485, and 385, respectively. Literature data confirms that carbaryl is mobile. Nkedi-Kizza and Brown (1998) reported K_f of 4.72 (1/n = 0.80) for soil with an organic content of 590 mg/Kg. They found that sorption was lower on subsoils and attributed this to a lower organic content. The reported K_{oc} values ranged from 144 to 671.

Column Leaching

In column leaching experiments (MRID 43320701), carbaryl residues were determined to be slightly mobile in columns (30-cm length) of sandy loam, silty clay loam, silt loam, and loamy sand soils treated with aged carbaryl residues. This disparity with the batch experiments may possibly be explained by the relatively poor extraction recovery, by slow desorption kinetics and by degradation during the aging period. Unextracted [^{14}C] labeled residues in the soils prior to leaching ranged from 19.0% of the recovered in the loamy sand soil to 39.7% in the silty clay loam soil. The study author believed that 50% of the carbaryl applied to the soil had degraded prior to leaching.

Field Dissipation

Studies of carbaryl dissipation in terrestrial, aquatic and forest environments have been submitted by the registrant. In forest environments carbaryl was found to be moderately persistent in soil (half-live = 65 days) and leaf litter (half-live = 75 days). The submitted field and aquatic dissipation studies were determined to be unacceptable, and did not provide useful information on movement and dissipation of carbaryl or its degradation products.

Field dissipation studies conducted in the 1960s and 1970s in terrestrial (Fiche/Master ID 000108961 and 00159337), aquatic (Fiche/Master ID 001439080, 0124378, 00159337, 00159338, 00159339) and forestry (Fiche/Master ID 00029738, 00159340, 00159341) environments and submitted in the 1980s have been reexamined. When they were initially reviewed they were not considered acceptable for a number of reasons including: sampling frequency was not sufficient to allow calculation of dissipation rates, degradates were not identified or quantified, soil, sediment and water were not sufficiently characterized, problems with analytical method specificity and validity, insufficient sampling frequency and sampling depth, lack of data on irrigation practices measures. These studies do not meet current levels of scientific validity required to be considered acceptable and do not provide useful information on field dissipation of carbaryl and its degradates.

The data requirements for terrestrial and aquatic field dissipation have not been fulfilled, and additional studies are required.

Terrestrial Field Dissipation

Results of two field dissipation studies conducted in California and North Carolina were submitted (MRID 41982605). Because of inappropriate sampling intervals, poor sample storage stability, lack of degradate monitoring, rainfall and irrigation that were less than evapotranspiration, and irrigation water with high pH, these studies do not provide reliable information on the rate of dissipation of parent carbaryl or formation of degradation products. The requirement for terrestrial field dissipation has not been fulfilled, and additional information is required. Because of problems with submitted studies additional field studies are required.

A freezer stability study was reportedly conducted but the results past 90 days were not submitted. There was apparently significant degradation within 90 days. Study samples were analyzed as long as 8 months after collection, making the quality of the data highly questionable. Degradates were not analyzed in either study, and the sampling interval was insufficient to accurately determine the dissipation rate for carbaryl. In the California study >80% of the applied carbaryl apparently dissipated between the final carbaryl application and the next sampling interval (4-7 days after the final application). In the NC study > 90 % apparently dissipated between application and the next sampling event (7days). However, in both studies dissipation after 7 days suggested a half-life on the order of weeks. In both studies rainfall and irrigation were less than evapotranspiration so the data can not be used to assess the potential for carbaryl to leach into the subsurface. In the California study, irrigation with water with a pH of 8.0 was applied 1-3 days after each pesticide application. Because carbaryl hydrolysis is highly pH dependant ($T_{1/2}$ at pH 9 = 3.2 hours) this may have resulted in significantly more rapid degradation.

Forestry Field Dissipation

In a supplemental forestry field dissipation study (MRID 43439801) carbaryl was applied on a pine forest site in Oregon. Carbaryl half-lives were found to be 21 days on foliage, 75 days in leaf litter and 65 days in soil. At the time of treatment, the trees of primary interest (pine) were 3-8 feet tall. Carbaryl concentration was a maximum of 264 ppm in the pine foliage at 2 days post-treatment, 28.7 ppm in the leaf litter at 92 days, 0.16 ppm in the upper 15 cm of litter-covered soil at 62 days, and 1.14 ppm in the upper 15 cm of exposed soil at 2 days. Carbaryl was detected in the leaf litter up to 365 days after treatment, and in the litter-covered soil up to 302 days after treatment. Carbaryl was $\leq$0.003 ppm in water and sediment from a pond and stream located approximately 50 feet from the treated area. This study was determined to provide only supplemental information because degradation products were not identified and their rate of formation and decline was not determined.

Aquatic Field Dissipation

Results of aquatic field dissipation studies conducted on rice in Texas and Mississippi were submitted (MRID 43263001). The studies were evaluated and found to be unacceptable. They do not provide useable information on the dissipation of carbaryl and 1-naphthol in aquatic field conditions. Frozen storage stability data were provided for only 6 months, although the water samples were stored for up to 14 months and the soil samples were stored for up to 17.5 months prior to analysis. The data suggest that carbaryl and 1-naphthol degraded significantly during storage. In the six months of storage carbaryl degraded an average of 34 % in Texas water and 39% in from Mississippi. 1-naphthol degraded 50% in water from Texas and 69% from Mississippi. Degradation did not appear linear, and it is not possible to extrapolate out to 14 months. It was therefore not possible to evaluate the actual concentrations of carbaryl and 1-naphthol in the samples or estimate the dissipation rates.

Bioaccumulation in Fish

Because of the low octanol/water partition coefficient carbaryl is not expected to significantly bioaccumulate. Reported K_{ow} values range from 65 to 229 (Bracha, and O'Brian, 1966; Mount, M.E. and Oehme, 1981; Windholz *et al.*, 1976). A fish bioaccumulation study reviewed in 1988 (Chib, 1986, Fiche/Master ID 00159342) suggested that bioaccumulation factors were 14x in edible tissue, 75x in visceral tissue and 45x in whole fish. Though the study does not meet current acceptable standards it does support the conclusion that significant bioaccumulation is not expected. No additional data on bioaccumulation is required at this time.

Foliar Dissipation

The reported rates of carbaryl dissipation from foliar surfaces varies from 1 days to 30 days. In their review of literature data on pesticide foliar persistence, Willis and McDowell (1987) report that carbaryl dissipation rates varied from 1.2 to 29.5 days. In the submitted forestry field dissipation study (MRID 43439801) carbaryl applied to pine needles dissipated with a half-live of 21 days. For terrestrial risk assessment modeling EFED used 35 days as the dissipation half-life.

Atmospheric Transport

Carbaryl has been shown to be transported and deposited by atmospheric processes (Waite, *et al.*, 1995; Foreman, *et al.*, 2000; Sanusi *et al.*, 2000). As with all chemicals applied by aerial or ground spray, spray drift can cause exposure to non-target organisms downwind. Beyer *et al.*, (1995) studied spray drift from aerial application to rangeland near the Little Missouri River in North Dakota. In 1991 carbaryl was applied to 35130 ha at 560 g/ha (0.62 lb) A.I. A 152 m no-spray buffer zone was maintained. River water samples collected 1 hour after completion of spraying had a mean concentration of 85.1 : g/l. Concentration decreased over time, and 96 hours after application the mean was 0.1 : g/l. In 1993 a similar application resulted in a maximum concentration 1 hour after spraying of 12.6 : g/l decreasing to 5.14 : g/L after 96 hours. The researchers found that invertebrates in the river were minimally effected while fish brain acetylcholinesterase activity was not effected.

Vapor phase transport and particulate transport may carry the compound far from the area of application. In the atmosphere, partitioning between particulate and gas phase is a function of temperature and changes from about 30% vapor phase to about 90% when temperature increases from 283 to 303 K (Sanusi *et al.*, 1999). This suggests that atmospheric transport distance and deposition are a function of temperature.

Carbaryl has been detected in air in urban and suburban areas with limited influence from agricultural spraying. It is detected more frequently and generally at higher concentrations at sampling locations in urban areas than in agricultural areas (Foreman *et al.*, 2000). Pesticide concentrations in fog often are higher than those observed in rain water or surface water and may represent a significant, though generally overlooked, route of exposure. Schomburg *et al.* (1991) reported carbaryl concentrations in fog ranging from 0.069 to 4.0 : g/L.

1-Naphthol Fate and Transport

Limited information is available for the environmental fate and transport of the major carbaryl degradate 1-Naphthol. 1-Naphthol was formed in laboratory degradation studies and represented a major portion of the applied mass (maximum of 22 % in aerobic aquatic metabolism, 58% in aerobic soil metabolism and 67% in photolysis). 1-Naphthol was not persistent in the studies and appears to have degraded more rapidly then the parent.

1-Naphthol a natural product and is also formed as a degradation product of naphthalene and other polycyclic aromatic hydrocarbons. It appears to degraded more rapidly then the parent in the submitted studies but there is not sufficient information the develop a detailed fate profile.
While guideline studies were not submitted specifically for the degradate, literature information suggests that it is less persistent and less mobile than parent carbaryl. Armbrust and Crosby (1991) reported that 1-Naphthol was stable to hydrolysis in filtered seawater at pH 7.9 and 8.3. Hydrolytic degradation of 1-naphthol is reported to be due to reaction with dissolved O_2 and is highly pH dependant (Karthikeyan and Chorover, 2000). Oxidation increases with pH and ionic strength. Below pH 7 oxidation is minimal and reaches a maximum at about pH 9. Oxidation of 1-naphthol reportedly results in production of (hydroxy)naphthoquinones and dimer coupled reaction products, though the reaction rates for 1-naphthol degradation is not well known (Karthikeya and Chorover, 2000). In filtered seawater carbaryl degraded rapidly to 1-naphthol under artificial sunlight (290-360 nm), with half-life of 5 hours. The degradation product, 1-naphthol, was degraded very rapidly with half-life of less than 1 hour (Armbrust and Crosby, 1991).

1-naphthol is degraded rapidly by microbial processes in aerobic systems. In an aerobic soil metabolism study (MRID 42785101) 1-naphthol degraded rapidly to non-detectable levels within 14 days. Armbrust and Crosby (1991) reported that 1-naphthol degraded in unfiltered seawater to below detectable level within 94 hours. Burgos *et al.* (1999) found that greater than 90% of aqueous 1-naphthol was degraded to CO_2 within 10 days. However, they found that sorption to soil greatly reduced the degradation rate; when sorbed degradation was greatly slowed to 25-40% degradation in 90 days.

No guideline information was submitted on 1-naphthol sorption. Literature information suggests that it is not strongly sorbed. Sorption to poorly crystalline aluminum hydroxide was pH dependant and appeared to occur only after oxidation (Karthikeyan *et al.*, 1999). Hassett *et al.* (1981) reported an average 1-naphthol K_{oc} of 431 (± 40) for 10 of the 16 soils tested. They also found that in other soils with very low organic carbon to clay ratios clay surfaces controlled sorption. Additional data on 1-naphthol sorption is required to fully characterize mobility.

Aquatic Exposure Assessment

Surface Water

Five crop scenarios: apples, field corn, sweet corn, oranges and sugar beets scenarios were used in modeling for surface water EEC. These crops were chosen as representative of the major groups of crops with high carbaryl use and application rates that would result in high potential for surface water contamination. The EEC's generated in this analysis were calculated using PRZM for simulating runoff from an agricultural field and EXAMS for estimating environmental fate and transport within the water body. Modeling was done using the maximum rate on label, average application rate and maximum rate of application reported.

Two sets of surface water simulations have been done for carbaryl: for drinking water assessment and for aquatic ecological exposure assessment. The modeling done for drinking water assessment was done using the index reservoir watershed scenario (Jones, *et al.*, 2000) and calculated values were corrected for Percent Crop Area (PCA). For ecological risk assessment modeling was done using the standard farm pond scenario. The standard pond scenario used by EFED simulates a ten-hectare field draining into a one-hectare static pond that is two meters deep and has no outlet. It is assumed that evaporation losses and inflow from rainfall and runoff are balanced. The inputs used are similar to those used in modeling drinking water EECs and are shown in Table 4. EECs generated (Table 5) were compared with toxicological information described below to estimate the risk to non-target aquatic organisms.

Table 4. PRZM/EXAMS environmental fate input parameters for Carbaryl

Parameter	Value	Data source
Molecular Weight	201.22	
Solubility	32 mg/L (@20°C)	Suntio, *et al.*, 1988
Vapor Pressure (torr)	1.36 10^{-6} @ 25° C	Ferrira and Seiber, 1981
Henry's Law Constant	1.28 x 10^{-8}	Suntio, *et al.* 1988
Hydrolysis Half-life pH 5 pH 7 pH 9	 stable 12 days 3.2 hours	MRID 00163847 44759301
Soil Photolysis Half-life (days)	stable	no valid data submitted
Aquatic Photolysis Half-life (days)	21 days	MRID 41982603
Aerobic Soil Metabolism Half-life	4.0 days (n=1 so use 3x)	MRID 42785101
Aerobic Aquatic Metabolism Half-life	4.9 days (n = 1 so use 3x)	MRID 43143401
Anaerobic Aquatic Metabolism Half-life	72.2 days	MRID 42785102
Soil-Water Partitioning Coefficient K_{ads} (K_{oc})	1.74 (207) sandy loam 2.0 (249) clay loam 3.0 (211) silt loam 3.5 (177) silty clay loam (K_{oc} = 209 for SCIGROW)	MRID 43259301

There are a number of factors which may limit the accuracy and precision of the PRZM/EXAMS modeling, including the selection of realistic exposure scenarios, the quality of the input data, the ability of the models to represent the real world and the number of years that were modeled. The scenarios that are selected for use in Tier II EEC calculations were chosen to be representative of uses likely to produce the highest concentrations in the aquatic environment. The EEC's in this analysis are accurate only to the extent that the model represents real environments. The most limiting part of the site selection is the use of the standard pond with no outlet. A standard pond is used because it provides a basis for comparing pesticides in different regions of the country on equal terms. The models also have limitations in their ability to represent some processes such as the handling of spray drift. A second major limitation is the lack of validation at the field level for pesticide runoff.

Table 5. Tier II surface water estimated environmental concentration (EEC) values derived from PRZM/EXAMS modeling for use in ecorisk assessment (Calculated using standard pond.)

Use Site, Application Method		Number of Applications Per Year	Application Rate (Pounds A.I. per Application)	Surface Water Acute (ppb) (1 in 10 year peak single day concentration)	21 day (ppb) (1 in 10 year)	60 day (ppb) (1 in 10 year)
Sweet Corn (OH), air/ground	Maximum	8	2	46	26	21
	"Average"	2	3.4	16	10	5
	Maximum Reported	3	1	14	8	4
Field Corn (OH), air/ground	Maximum	4	2	28	16	10
	"Average"	2	1	12	6	3
	Maximum Reported	2	1.5	18	9.5	5
Apples (OR), air/ground	Maximum	5	2	8.6	4.9	4
	"Average"	2	1.2	4.5	2.5	1
	Maximum Reported	2	1.6	6.0	3	2
Sugar Beets (MN), air/ground	Maximum	2	1.5	19	11	5
	"Average"	1	1.5	14	7	3
	Maximum Reported	1	1.2	11	5	2
Oranges (FL), air/ground	Maximum	4	5	274	137	79
	"Average"	2	3.4	145	67	33
	Maximum Reported	3	4.3	232	112	55

Urban and Suburban

EFED has limited tools for assessing the effects of pesticide use in urban and suburban settings on surface water and groundwater quality. Carbaryl is extensively used in such non-agricultural applications, resulting in widespread surface water contamination. This conclusion is based on monitoring data. In urban and suburban areas small streams are generally greatly affected by surface runoff and water collection into storm sewers. These small streams can provide a significant habitat for aquatic animals, and this habitat can be severely degraded by runoff of urban pesticides. Garden and lawn care products and other outdoor uses contribute to carbaryl presence in storm sewers and streams. Monitoring data show that about 50% of urban streams have measurable concentrations (>0.01 : g/L) of carbaryl compared to less than 10% of agricultural sites (Larson, *et al.*, 1999). Additional information is needed to adequately assess the environmental impacts of urban and suburban uses. Targeted surface water and groundwater monitoring studies are required to more adequately understand the movement of the compound in these environments and to provide estimates of the distribution of possible exposures from urban and suburban environments.

Estimated Environmental Concentrations for Terrestrial Ecological Risk Assessment

For terrestrial EECs, EFED uses the concentration of a chemical on food items derived from the Kenaga nomograph, as modified by Fletcher *et al.* (1994). The nomograph allows estimation of the concentration of pesticide on food items resulting from application, based on a large set of actual field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenaga, 1972). Hoerger-Kenaga pesticide environmental concentration estimates were based on residue data correlated from more than 20 pesticides on more than 60 crops. Representative of many geographic regions (7 states) and a wide array of cultural practices, Hoerger-Kenaga estimates also considered differences in vegetative yield, surface/mass ratio and interception factors. In 1994, Fletcher *et al.* reexamined the Hoerger-Kenaga simple linear model ($y=B^1x$, where x=application rate and y=pesticide residue in ppm) to determine whether the terrestrial EEC's were accurate. They compiled a data set of pesticide day-0 and residue-decay data involving 121 pesticides (85 insecticides, 27 herbicides, and 9 fungicides from 17 different chemical classes) on 118 species of plants. They concluded that Hoerger-Kenaga estimates needed only minor modifications to elevate the predictive values for forage and fruit categories from 58 to 135 ppm and from 7 to 15 ppm, respectively. Otherwise, the Hoerger-Kenaga estimates were accurate in predicting the maximum residue values after a 1 lb ai/acre application.

EFED calculates concentration over time assuming first order dissipation from plant surfaces. In the absence of reliable foliar dissipation data a dissipation half-life of 35 days is used. Published literature shows that carbaryl dissipation rates vary. and are among the highest observed for any pesticide. (Willis and McDowell, 1987). ELL-FATE, a spreadsheet based first order decay model was used to calculate concentration over time for multiple applications at the label maximum, "average," and maximum reported application rates. A more thorough description of the model calculations and ELL-FATE outputs are attached in Appendix D. EEC values calculated for different crop applications are presented in Tables 4, 7, 8, and 9, Appendix B.

5.0 Drinking Water Assessment

Water Resources Assessment

Chemical characteristics and available monitoring data indicate that carbaryl has the potential to enter surface water via leaching and runoff under certain conditions and has limited potential to leach to ground water. Carbaryl tends not to bind tightly to soil, aquifer solids, or sediment. Once the compound has entered surface water, it may be degraded by chemical and biological processes. Abiotic degradation by photolysis ($t_{1/2}$ = 21 days) and hydrolysis in alkaline ($t_{1/2}$ = 3.2 hours at pH 9) and neutral ($t_{1/2}$ = 12 days at pH 7) waters result in fairly rapid degradation in most aqueous environments. Microbially mediated processes also contribute to fairly rapid degradation of the parent to 1-naphthol and CO_2. Aerobic aquatic, soil aerobic and anaerobic metabolism studies ($t_{1/2}$ = 5, 4, and 72 days respectively) suggest that the compound is broken down by a variety of metabolic processes.

Under certain limited conditions carbaryl may be expected to persist in the environment. Under low pH conditions the compound is stable to hydrolysis. In anaerobic environments metabolism is fairly slow ($t_{½}$ = 72 days).

Surface water monitoring studies show that carbaryl is the second most widely detected insecticide after diazinon. Carbaryl, at typically low concentrations, is found in greater than 20 %

of surface samples in NAWQA studies at concentrations up to 5.5 ppb. Carbaryl is detected more frequently in non-agricultural areas (about 40%) then in agricultural areas (about 5 %). A maximum carbaryl concentration of 8.4 ppb was reported for surface water samples in the California DPR surface water database. Carbaryl is generally not widely detected in groundwater monitoring studies though some studies have found concentrations of up to several hundred ppb. Concentrations as high as 610 µg/L have been detected in one case but typical groundwater concentrations are much lower. NAWQA studies have found that about 1 % of groundwater samples have measurable levels (> 0.003 : g/L) of carbaryl, with a maximum concentration of 0.02 µg/L. Targeted studies designed to measure carbaryl in groundwater are not available.

Drinking Water Exposure Assessment

Based on chemical properties, existing monitoring data and computer simulation estimates of carbaryl contamination that can be expected in surface water and groundwater as a result of normal use practices have been determined. Carbaryl is the second most commonly detected insecticide in surface water, and can be expected to contaminate drinking water derived from surface water bodies. Targeted and non-targeted studies regularly detect carbaryl in low concentrations, typically below 1 µg/L. Monitoring studies suggest that about 20 % of surface water bodies have detectable (>0.01 : g/L) levels of the compound. The maximum reported value in surface water was 8.4 µg/L.

Carbaryl is not widely detected in groundwater studies. Drinking water derived from groundwater has been found to have low or non-detectable levels of carbaryl. For drinking water derived from groundwater, the acute and chronic EEC value of 0.8 µg/L is based on modeling using SCI-GROW. It must be noted that carbaryl has an aerobic metabolism half-life (4 days) which is significantly outside the range of values for which SCI-GROW may be valid (17-1000 days). Because of this there is significant uncertainty in the SCI-GROW value. EFED currently does not have more advanced groundwater models, and targeted studies specifically designed to evaluate the potential for carbaryl to move to groundwater are not available.

Because of its chemical structure carbaryl is somewhat difficult to quantify by gas chromatography. Older studies using GC or GC/MS generally have poor recovery and quantitation limits. Because of this difficulty in analysis the actual concentration of carbaryl in groundwater and surface waters may be higher than reported. More recent studies using HPLC/MS should provide better data on the true extent and magnitude of water contamination from the use of carbaryl.

Drinking Water Modeling

Modeling to support the assessment of drinking water in the human health risk assessment was done for five scenario: Florida citrus, Ohio sweet corn and field corn, Oregon apples and Minnesota sugar beets. These scenarios were selected to represent the range of crops and use rates likely to result in higher environmental concentrations. EECs were calculated using The Pesticide Root Zone Model version 3.12 (PRZM) (Carsel *et al.*, 1997) and EXAMS 2.97.5 (Exposure Analysis Modeling System) (Burns, 1997) were run. PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field and EXAMS estimates environmental fate and transport of pesticides in surface water. Weather and agricultural practices are simulated over 36 years so that the 10-year exceedance probability at the site can be estimated. A partial list of input parameters for the PRZM/EXAMS modeling are given in Table 4. Simulations were run using the maximum application rates, average rates, and maximum reported rates. The values generated by the models were multiplied by a default percent crop area factor (PCA) which accounts for the fact that is unlikely for any basin to be completely planted to agricultural crops. For human health assessment, simulations were done using the Index Reservoir scenario in Exams. The Index Reservoir and PCA are described in Jones *et al.*, 2000. The EEC's for the five scenarios simulated are shown in Table 6. Input files for PRZM/EXAMS modeling is included in Appendix A.

The maximum calculated EEC resulted from use on citrus in Florida. For the Index Reservoir scenario using maximum label rates, acute EEC values ranged from about 10 μg/L from sugar beets to about 500 μg/L from citrus (Table 6). Chronic EECs ranged from about 2 to 28 μg/L. These values are higher then concentrations observed in monitoring studies and probably represent conservative estimates of environmental concentrations. It is highly unlikely that any but the most extensive targeted monitoring would capture the actual peak concentrations. The results of the modeling provide a very conservative, though not unreasonable, estimate of possible concentrations in drinking water. A more detailed assessment of the source of water used to provide drinking water and the relationship between the areas where carbaryl is used and surface water sources is required to more accurately evaluate possible human exposures. In Florida, for example, the majority of drinking water is derived from groundwater (> 90%) so high surface water concentrations do not necessary indicate high exposure. Until more accurate data on land use and related pesticide application is available and can by linked with data on the location and hydraulic characteristics of the water bodies it is not possible to provide more accurate assessment of possible exposures. A more detailed description of modeling is presented below, and model input and output files are attached in Appendix A.

Water Treatment Effects

The Office of Pesticide Programs has completed a preliminary review of the effects of drinking water treatment on pesticides in water (http://www.epa.gov/scipoly/sap/2000/september/sept00_sapdw_0907.pdf). This review indicates that standard drinking water treatment, consisting of flocculation/sedimentation and filtration does not substantially affect concentrations of pesticides in drinking water. Evidence suggests that carbaryl does not react with chlorine or hypoclorite disinfection products in water treatment but is rapidly degraded ($T_{1/2}$ = too rapid to measure) by ozone (Mason *et al.*, 1990). Since relatively few water treatment facilities in the U.S. use ozone the limited data available do not indicate that carbaryl is likely to be degraded in the majority of treatment plants.

Table 6. Drinking Water EECs

Crop		Number of Applications per Year	Pounds A.I. per application	Surface Water Acute (ppb) (1 in 10 year peak single day concentration)	Surface Water Chronic (ppb) (1 in 10 year annual average concentration)
Sweet Corn (OH) (PCA = 0.46)	Maximum[1]	8	2	37	3.2
	Average[2]	2	3.4	45	2.2
	Maximum[3] Reported	3	1	15	0.9
Field Corn (OH) (PCA = 0.46)	Maximum[1]	4	2	30	2.1
	Average[2]	2	1	13	0.6
	Maximum[3] Reported	2	1.5	20	1
Apples (OR) (PCA = 0.87)	Maximum[1]	5	2	144	9
	Average[2]	2	1.2	12	0.7
	Maximum[3] Reported	2	1.6	25	1
Sugar Beats (MN) (PCA = 0.87)	Maximum[1]	2	1.5	19	2
	Average[2]	1	1.5	12	1.1
	Maximum[3] Reported	1	1.2	9	0.9
Oranges (FL) (PCA = 0.87)	Maximum[1]	4	5	494	28
	Average[2]	2	3.4	246	11
	Maximum[3] Reported	3	4.26	411	16
Surface Water Monitoring				5.5 (Maximum Observed Concentration)	
Groundwater (SCI-GROW)	Maximum[1]	5	4	0.8	0.8
Groundwater (NAWQA Monitoring Data)				0.02	0.02

[1] Maximum application rate on label
[2] Average application rate from Quantitative Usage Analysis for Carbaryl, prepared July 21, 1998 by Frank Hernandez, OPP/BEAD
[3] Maximum rate of application reported in Doanes survey data

Groundwater Resources

Available evidence from valid scientific studies show that carbaryl has a limited potential to leach to ground water. As a result of normal agricultural use, detections of carbaryl residues have been reported in groundwater from several states. As reported in the U.S. EPA. Pesticides in Groundwater Database (Jacoby *et al.*, 1992) carbaryl was detected in 0.4% of wells sampled. Carbaryl was detected in California (2 out of 1433 wells), Missouri (11 out of 325 wells), New York (69 out of 21027 wells) Rhode Island (13 out of 830 wells) and Virginia (11 out of 138 wells). The maximum concentration detected was 610 µg/L in NY, though typically the measured concentrations were significantly lower.

The EPA STORET database was queried on May 12, 1999 for reports of measurements of carbaryl in groundwater. The database contained 9389 records indicating that analysis was done for carbaryl. Out of these only 4 reported concentrations above the detection limits. These analyses were all from one well in Cleveland, OK in 1988. The 4 reported concentrations were between 0.8 and 1 ppb.

Carbaryl was detected at greater than the detection limit (0.003 µg/L) in 1.1 % of groundwater samples from 1034 sites across the U.S. by U.S.G.S. NAWQA program. The maximum observed concentration was 0.021 µg/L. Detections were mainly from three use sites: wheat (5.8 % of well samples from wheat land use), orchards and vineyards (1.7 % of well samples from orchard and vineyard land use), and urban (1.8% of urban groundwater samples). Data on pesticides in groundwater were reviewed by Kolpin *et al.* (1998) and updated information is available at: http://water.wr.usgs.gov/pnsp/pestgw/.

Surface Water Resources

Monitoring Data

Carbaryl is widely detected in non-targeted and targeted monitoring studies. Observed concentrations are generally low (> 0.5 : g/L). Carbaryl is not very persistent in most surface water conditions suggesting that the wide spread occurrence is a result of its extensive use in a variety of applications. Because of limitation in the analytical methods used there is some uncertainty in the quantitative accuracy of carbaryl analysis.

NAWQA

Carbaryl is the second most widely detected insecticide after diazinon in the USGS NAWQA program (http://water.usgs.gov/nawqa/nawqa_home.html). Carbaryl was detected in 46% of 36 NAWQA study units between 1991 and 1998. The reported concentrations are believed to be reliable detections but have greater than average uncertainty in quantification. The data in the NAWQA database are amended with an "E" qualifier to indicate the variability found in the analysis. This suggests that the reported values may not represent the maximum concentrations that exist.

Carbaryl (along with diazinon) was one of the two most widely detected insecticides. Out of 5220 surface water samples analyzed 1082, or about 21 percent, were reported as having detections greater than the MDL. The maximum reported concentration was 5.5 µg/L. For samples with positive detections the mean concentration was 0.11 :g/L, with a standard deviation of 0.43 :g/L. A significant portion of the total carbaryl applied was transported to streams. In areas with high agricultural use the load measured in surface waters was relatively consistent across the country at about 0.1 percent of the amount used in the basins (Larson *et al.*, 1999) http://water.wr.usgs.gov/pnsp/rep/wrir984222/load.html. The estimated carbaryl use on in agricultural applications is about 2.5 million pounds suggesting that 2,500 pounds are delivered to the nations streams draining agricultural areas.

Streams draining urban areas showed more frequent detections and higher concentrations than streams draining agricultural or mixed land use areas. For example Kimbrough and Litke (1996) reported that, in the South Platte River Basin Study Unit, between April and December of 1993, carbaryl was detected in 14 urban drainage samples and 6 agricultural drainage samples. Carbaryl had the highest concentration of the four insecticides analyzed with a maximum concentration of 2.5 :g/L in the urban basin and 1.5 :g/L in the agricultural basin (http://webserver.cr.usgs.gov/nawqa/splt/meetings/KIMB1.html). In the South-Central Texas Study Unit carbaryl was detected in 12% of streams draining agricultural areas and 52 % draining urban areas (Bush *et al.*, 2000) http://water.usgs.gov/pubs/circ/circ1212/.

Registrant Monitoring Study

Aventis Crop Science initiated in February 1999 a surface water monitoring study of carbaryl residues in surface water in areas believed to have high agricultural and residential use, based predominantly on county-level sales data. A total of 20 sites are monitored, with "medium-sized watersheds" targeted: 16 sites in agricultural areas and 4 in areas draining suburban areas. Samples of raw water were collected at municipal water treatment facilities. When raw water analyses detected carbaryl, stored finished water samples (collected at the same time) were analyzed. Samples were collected weekly during periods suspected of being "high risk" and monthly the rest of the year in agricultural areas. Suburban sites were sampled weekly. The study was originally envisioned to last for one year, but was extended for an additional year in February, 2000 (amendment 7), and for a third year in February, 2001 (amendment 9). Carbaryl was analyzed by HPLC/MS/MS with a limit of detection of 0.002 ppb (2 ppt) and a limit of quantitation (LOQ) of 0.030 ppb (30 ppt).

OPP has received two interim reports of monitoring from this study. The first report (MRID 45116201) has been fully reviewed and results are described below. Very recently a second report was received by OPP/EFED. Results from this latest report (MRID 45394101) have not been reviewed in depth, but are similar to results from year-one.

Carbaryl was widely detected at surface water sites monitored in this study. Samples containing carbaryl were detected in raw drinking water samples collected at all four suburban monitoring locations, and at about three quarters of the agricultural monitoring locations (13 of 16 sites). Carbaryl was not detected as frequently in finished drinking water samples when they were analyzed; however, only a small subset of finished water samples were actually analyzed. This represents a significant flaw in the study design and limited its usefulness for evaluating the effects of treatment. Differences in concentrations between raw and finished drinking water are likely attributed more to changes in the concentration of source water than to effects of treatment. Most carbaryl detections in this study were at low levels, below the LOQ of 0.03 ppb. Carbaryl contamination measured in this monitoring study appears to be transient, and therefore it is unlikely that any but the most intensive field sampling would ever detect the actual peak concentration that occurs at a site. The interim study reports have not adequately addressed why concentrations found in this study, which claims to target high carbaryl use areas, are substantially lower than those measured in the untargeted USGS NAWQA studies. That, and the limited number of sites sampled, limit the usefulness of this study.

Summary of year-one monitoring

In raw water samples from suburban sites detectable residues in raw water ranged from 0.002 to 0.023 ppb. 11 out of 40 raw water samples from Sweetwater Creek, the source of water for the East Port facility in Douglas, GA had detectable levels ranging from 0.002 to 0.018 ppb. One out of 46 samples from Joe Pool Lake, Ellis Texas had a detection at 0.014 ppb. Jorden Lake in Cary, NC had 2 detections out of 44 samples (0.004 and 0.003 ppb). 11 out of 40 samples from the Cahaba River in Birmingham AL had detections ranging from 0.002 to 0.023 ppb. Finished water sampled from suburban areas were all below the detection limit.

In samples from agricultural sites 9 out of 15 water sources had some detectable level of carbaryl. The detections were generally at low levels, with one of about 0.16 ppb and one of 0.031. The rest were below the level of quantitation (<0.030 ppb). Samples from finished water were generally lower than raw water, though it appears that raw and finished water sampling did not sample the same mass of water. Therefore, the data can not be used to evaluate the effectiveness of water treatment on carbaryl. Because the samples were collected at the same time, the water exiting the treatment plant was temporally different than the water entering and represent different, independent, parcels of water. In several cases finished water had higher concentrations than raw water, and finished water had detectable carbaryl when the raw did not. The highest concentration measured was in finished water (0.18 ppb). Raw water sampled at the same time had much lower concentration (0.010).

Non-targeted monitoring, such as the NAWQA program, has shown that much higher concentrations occur indicating that this study, while useful, can not be used to describe the overall distribution of concentrations that occur throughout the entire use area. This study does not provide sufficient information to allow estimation of actual peak and mean concentrations that actually occur in all use areas. The highest concentration values measured in this study are close to the average values seen in other, non-targeted, studies.

Only limited information was submitted on sampling site selection and how the sites relate to the overall distribution of use areas. Home and garden sites were selected downstream of urban/suburban areas that were believed to have high use based on county scale sales data.

Agricultural sites were selected based on county scale sales data, and are believed to be in "major use counties."

This study is still ongoing and only interim study results have been submitted. Additional information is needed to evaluate the study results. Additionally, an analysis of how the selected sites relate to the nationwide distribution of carbaryl use areas is required. This should include an explanation of why this study did not observe concentrations as high as those found in other, non-targeted studies, and how the results of this study can be related to concentrations that occur throughout the country. Based on the interim data submitted it appears that this study measured concentrations similar to those observed in non-targeted studies but did not capture high end or peak values. Until additional information is submitted it is not possible to use these interim results for more then to reinforce the inferences drawn from non-targeted study data.

Sacramento-San Joaquin River Delta

As part of a two year study into the cause of declines in aquatic insects in California's Sacramento-San Joaquin Delta, toxicity of surface water was measured using ceriodaphnia. When toxicity was found, toxic identification evaluation was done to determine the causative agent. Carbaryl was found to be the primary toxicant at one of 20 sites sampled in 1995, with concentration of 7.0 : g/L. The toxicity seemed to persist for several days (Werner, *et al.*, 2000).

STORET

The EPA STORET database (was queried on May 12, 1999 for reports of measurements of carbaryl in surface water. The database contained 8048 records indicating that analysis was done for carbaryl. Out of these 432 reported concentrations above the detection limits. The maximum value reported was 5.5 µg/L. Of the reported detections 18 were above 1 ppb. The data is the STORET database is used to give a general indication of the occurrence pattern only. Lack of QA/QC and analytical methodology limitations limit the usefulness of the STORET data. However, reported detections of carbaryl suggest that the compound is infrequently detected in surface water and at low levels.

6.0 Hazard and Risk Assessment for Aquatic Organisms

Hazard Assessment for Aquatic Organisms

Freshwater Fish

On an acute basis, technical carbaryl is moderately to highly toxic to freshwater fish and to fish that spend a portion of their life cycle in fresh water, such as the Atlantic salmon (LC_{50} = 0.25 - 20 ppm). LC_{50} values for the typical end use products range from 1.4 to 290 ppm, falling in the moderately to practically nontoxic categories. Calculation of acute and chronic risk quotients for freshwater fish are based on an Atlantic salmon LC_{50} of 250 ppb and a fathead minnow NOAEC of 210 ppb, respectively.

Amphibians

According to an available supplemental study with a 50% carbaryl formulation, the LD_{50} for the bullfrog (*Rana catesbeiana*) is greater than 4,000 mg/kg, or practically nontoxic (MRID 00160000). A single acute exposure of plains leopard frog tadpoles (*Rana blairi*) to carbaryl concentrations in the 3.5 - 7.2 mg/L range led to a 90% reduction in swimming activity, including sprint speed and sprint distance, activity ceasing completely at 7.2 mg/L (Bridges 1997). This reduction in activity and swimming performance may result in increased predation rates and, because activity is closely associated with feeding, may result in slowed growth that could lead to failure to complete metamorphosis. Acute exposure to low carbaryl levels may not only affect immediate survival of tadpoles but also impact critical life history functions.

On a chronic basis, carbaryl has been shown to have the potential to adversely affect amphibians. In a recent study, nearly 18% of southern leopard frog (*Rana sphenocephala*) tadpoles exposed to carbaryl during development exhibited some type of developmental deformity, including both visceral and limb malformations, compared to a single deformed (< 1%) control tadpole demonstrating that carbaryl exposure can result in amphibian deformities (Bridges, 2000). Although the length of the larval period was the same for all experimental groups, tadpoles exposed throughout the egg stage were smaller than their corresponding controls. Because exposure to nonpersistent chemicals may last for only a short period of time, it is important to examine the long-term effects that short-term exposure has on larval amphibians and the existence of any sensitive life stage. Any delay in metamorphosis or decrease in size at metamorphosis can impact demographic processes of the population, potentially leading to declines or local extinction.

Freshwater Invertebrates

Carbaryl is very highly toxic to aquatic invertebrates (1.7 - 26 ppb) on an acute basis. This compound also has a very strong potential for chronic effects to invertebrates (NOAEC = 3.3 ppb). Field studies that evaluated populations of damselflies (*Xanthocnemis zealandica*) after exposure to 100 µg/L carbaryl showed a 90% reduction in emergence success after 10-12 days exposure (Hardersen and Wratten, 1998). Studying natural plankton communities in enclosed mesocosms, Havens (1995) reports a decline in total zooplankton biomass and individuals across the range of carbaryl treatments (0 - 100 ug/L). Furthermore, at carbaryl concentrations greater than 20 µg/L *Daphnia* was no longer found and that at concentrations above 50 ug/L all cladocerans were eliminated, resulting in an increase in algal biomass, representing a repartitioning of biomass from zooplankton to phytoplankton. Hanazato (1995) exposed *Daphnia ambigua* to carbaryl and a kairomone released by the predator *Chaoborus* (phantom midge) simultaneously. *Daphnia* developed helmets in response to the kairomone, but not in response to carbaryl at 1-3 µg/L. However, carbaryl enhanced the development of high helmets and prolonged the maintenance period of the helmets in the presence of the kairomone, suggesting that at low concentrations carbaryl can alter predator-prey interactions by inducing helmet formation and vulnerability to predation in *Daphnia*. In related mesocosms studies, exposure to carbaryl at 1 ppm killed all plankton species, including *Chaoborus* larvae (Hanazato, 1989). However, this concentration is well above the maximum EECs modeled for carbaryl, and is unlikely that such high levels of this chemical would be found under field conditions. Mora *et al.* (2000) studying the relationship between toxicokinetics of carbaryl and effects on acetylcholinesterase (ACHase) activity in the snail, *Pomaca patula,* observed increased enzyme inhibition, along with the bioconcentration of carbaryl, after 72 hours of exposure to sublethal levels (3.2 ug/g). The transfer of snails to carbaryl-free water was followed by rapid monophasic elimination with a half-life of 1.0 hour, although ACHase activity levels never returned to control values. The risk assessment for freshwater invertebrates is based on a stonefly LC_{50} of 1.7 ppb and a water flea NOAEC of 1.5 ppb, respectively.

Estuarine/Marine Fish

Carbaryl is categorized as moderately toxic to estuarine/marine fish on an acute basis, based on a minnow LC_{50} of 2.6 ppm. Laboratory exposure to a single dose of carbaryl at 100 ppb can adversely affect schooling behavior in the silverside (Weis and Weis, 1974). Exposure to carbaryl at 10 ppb caused retardation of fin regeneration during the first week of the study in the killifish (*Fundulus heteroclitus*) (Weis and Weis 1975). Field exposure to a maximum carbaryl water concentration of 1.2 ppm affected burying behavior in caged English sole young (Pozorycki, 1999). The acute risk assessment for estuarine/marine fish is based on a sheepshead minnow LC_{50} of 2.6 ppm. At present, the chronic NOAEC for marine/estuarine fish has not been established, therefore additional chronic toxicity studies are required. Guideline 72-4(a) is not fulfilled.

Estuarine/Marine Invertebrates

Technical carbaryl is categorized as very highly toxic to estuarine/marine shrimp species and moderately toxic to oysters on an acute basis. The mysid LC_{50} falls in the 5.7 - 9.6 ppb range and the oyster LC_{50} is 2.7 ppm. Typical end-use carbaryl products are considered very highly toxic to mysids and slightly toxic to oysters. Carbaryl applied to oyster beds in Washington State tidelands at 7.5 - 8 lb ai/acre to control ghost and mud shrimp has been shown to be lethal to many nontarget invertebrate species. The acute risk assessment for estuarine/marine invertebrates is based on a mysid LC_{50} of 5.7 ppb. There is insufficient data to assess the chronic risk for estuarine/marine invertebrates. Additional chronic toxicity studies are required. Guideline 72-4(b) is not fulfilled.

Aquatic Plants

Data based on a single available core toxicity study with the green alga *Pseudokirchneria subcapitata* (formerly *Selenastrum capricornutum*) indicates that the LC_{50} and NOAEC are, respectively, 1.1 ppm and 0.37 ppm . Toxicity testing for the following four aquatic plants is required to support carbaryl's registered forestry uses; duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), freshwater blue-green algae (*Anabaena flos-aquae*), and a freshwater diatom. Guideline 122-2 is not fulfilled.

1-Naphthol

1-naphthol, the major metabolite of carbaryl degradation by abiotic and microbially mediated processes is moderately to highly toxic to aquatic organisms on an acute basis. LC_{50} values range from 0.75 to 1.6 ppm for freshwater fish, from 1.2 to 1.8 ppm for estuarine/marine fish, from 0.70 to 0.73 ppm for freshwater invertebrates, and from 0.21 to 2.5 ppm for estuarine/ marine invertebrates.

Risk Assessment for Aquatic Organisms

A detailed analyses of risk quotients (RQs) in relation to their corresponding levels of concern (LOCs) is presented in Appendix B. A summary of the acute and chronic LOC exceedances for aquatic organisms, based on maximum label rates, is presented in Tables 7 and 8.

Freshwater Fish

Carbaryl is highly to slightly toxic to freshwater fish (LC_{50} = 0.25 - 20 ppm) on an acute basis. The acute risk LOC (0.5) for freshwater fish is exceeded for one of five use scenarios modeled (citrus), at maximum label (RQ: 1.10), "average" (RQ: 0.58), and maximum reported (RQ: 0.93) use rates, and not exceeded for the other four scenarios (sweet corn, field corn, apples, sugar beets). The chronic risk LOC is not exceeded for any of the five use scenarios modeled (Table 7). These data suggest that carbaryl uses may present a risk to freshwater fish only under situations that combine high application rates and runoff into water bodies, such as ponds or lagoons, where the chemical may reach toxic levels.

Sublethal effects have been documented in the literature showing that in fish the inhibition of acetycholinesterase (AChE) can effect thyroid and gonadal dysfunction in the freshwater murrell, *Channa punctatus*, resulting in ACh accumulation. At the 0.21 ppm concentration level carbaryl was found to reduce pituitary and serum gonadotropin levels accompanied by inhibition of hypothalamic gonadotropin releasing hormone (GnRH) (Bhattacharya, 1993). These test concentration are at the upper end of the water EECs modeled for carbaryl (citrus scenario).

Freshwater Aquatic Invertebrates

Acute and chronic risk LOCs are exceeded for freshwater invertebrates for all five carbaryl use aquatic scenarios modeled using maximum label use rates (acute RQs = 5.06 - 161.18, chronic RQs = 3.27 - 91.33), maximum reported rates (acute RQs = 3.30 - 136.47, chronic RQs = 2.00 - 74.67), and "average" rates (acute RQs = 2.65 - 85.29, chronic RQs = 1.67 - 44.67), indicating that most carbaryl uses are likely to pose acute and chronic risks to freshwater invertebrates, especially to arthropods. Although carbamates and OP's breakdown rapidly in the environment, studies pertaining to agricultural regions where these insecticides are applied for extended periods of the year have shown that nontarget aquatic invertebrates may be exposed to high levels of ChE inhibiting compounds for a period of up to several months (Gruber and Munn, 1998). In general, due to its rapid metabolism and rapid degradation, carbaryl should not pose a significant bioaccumulation.

Table 7. Summary of acute and chronic risk LOC exceedances, based on maximum label application rates, for freshwater organisms[1]

Organism	Use site Scenarios	Risk Quotients Equal or Exceed Level of Concern for:			
		Acute Risk (RQs)	Acute Restricted Use	Acute Endangered Species	Chronic Risk
Fish	Sweet Corn	NO	YES	YES	NO
	Field Corn	NO	YES	YES	NO
	Apples	NO	NO	NO	NO
	Sugar Beets	NO	NO	YES	NO
	Citrus	YES (1.1)	YES	YES	NO
Aquatic Invertebrates	Sweet Corn	YES (27.1)	YES	YES	YES (17.3)
	Field Corn	YES (16.5)	YES	YES	YES (10.7)
	Apples	YES (5.1)	YES	YES	YES (3.3)
	Sugar Beets	YES (11.2)	YES	YES	YES (7.3)
	Citrus	YES (161.2)	YES	YES	YES (91.3)

[1] **Levels of concern (LOCs) for aquatic organisms**

Acute Risk	0.5
Acute Restricted Use	0.1
Acute Endangered species	0.05
Chronic Risk	1

Estuarine/Marine Fish

Carbaryl is moderately toxic to estuarine/marine fish (LC_{50} = 2.6 ppm); however, no acute LOCs are exceeded for any of the five use scenarios modeled, at any use rate (Table 8). Thus, most carbaryl uses are unlikely to pose an acute risk to marine/estuarine fish. Although a NOAEC based on core data has not been established, evidence from the open literature indicates that exposure to low carbaryl levels may produce adverse physiological and behavioral effects in estuarine/marine fish. Laboratory exposure of *Menidia menidia* to a single dose of carbaryl (100 ppb) resulted in the disruption of schooling behavior, as carbaryl-exposed groups consistently occupied twice the space of control groups, which was attributed to the accumulation of the carbaryl degradate 1-naphthol (Weis and Weis, 1974). Exposing the killifish (*Fundulus heteroclitus*) to carbaryl at 10 ppb in the laboratory caused retardation of fin regeneration during the first week of the study (Weis and Weis 1975). According to Pozorycki (1999), field studies with caged juvenile English sole (*Pleuronectes vetulus*) indicated that brain acetylcholinesterase (AChE) activity decreases following carbaryl application, affecting the ability to bury in sediments. Mean brain AChE inhibition was 26% in fish placed on treated mudflats and 24% in fish placed subtidally, but maximum individual values approached 50%. AChE inhibition at 50-60% was noted as a threshold value below which burying decreased sharply. Maximum carbaryl water concentration measured by HPLC was 1.2 µg/ml at the cage sites. Sediment concentrations on treated mudflats were as high as 23 µg/g 24 hrs after application. Chronic toxicity studies with an estuarine/marine fish species is required.

There is one carbaryl use in particular that represents a potential acute and chronic risk to estuarine/marine fish. Since 1963, carbaryl has been used to treat two tideland areas of Washington State for the control of two species of burrowing shrimp in commercial oyster beds. The acute risk to fish inhabiting treated mudflats or trapped in shallow pools is extremely high, often resulting in fish kills. Exposure to sublethal carbaryl levels has also been shown to inhibit acetylcholinesterase in fish in subtidal areas adjacent to the treated sites resulting in a significant, although reversible, impairment of burying behavior, thus increasing their exposure to predators. Carbaryl is applied aerially, at the rate of 7.5 - 8 lb ai/acre (maximum label rate) over oyster seed beds and bare mudflats on a combined total of 800 acres of tidelands in Willapa Bay and Grays Harbor, Washington, to control burrowing shrimp populations (*Neotrypaea*[5] *californiensis* and *Upogebia pugettensis*). Applications are made when shrimp population densities meet the established action threshold of 10 burrow holes per square meter. On average, oyster beds are treated once every six years (Feldman *et al.* 2000). Unchecked, these shrimp can adversely affect oyster production by making the substrate unsuitable for oyster culture and by competing with these bivalves for food resources (Hulburt *et al.* 1989).

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[5]Also referred in the literature as *Callianassa californiensis*.

Table 8. Summary of acute risk LOC exceedances, based on maximum label application rates, for marine/estuarine organisms[1]

Organism	Use site Scenarios	Risk Quotients Equal or Exceed Level of Concern for:			
		Acute Risk (RQs)	Acute Restricted Use	Acute Endangered Species	Chronic Risk
Fish	Sweet Corn	NO	NO	NO	No Data
	Field Corn	NO	NO	NO	No Data
	Apples	NO	NO	NO	No Data
	Sugar Beets	NO	NO	NO	No Data
	Citrus	NO	YES	YES	No Data
Aquatic Invertebrates	Sweet Corn	YES (27.1)	YES	YES	No Data
	Field Corn	YES (16.5)	YES	YES	No Data
	Apples	YES (5.1)	YES	YES	No Data
	Sugar Beets	YES (11.2)	YES	YES	No Data
	Citrus	YES (161.2)	YES	YES	No Data

[1] Levels of concern (LOCs) for aquatic organisms

Acute Risk	0.5
Acute Restricted Use	0.1
Acute Endangered species	0.05
Chronic Risk	1

In addition to providing a substantial portion of U.S. oyster production, these estuaries are also important nurseries for several valuable fisheries. Estimates of potential fish kills in the treated area range from 15,000 to 96,000. Species killed following carbaryl applications include staghorn sculpin (*Leptocottus armatus*), saddleback gunnels (*Pholis ornata*), English and sand sole (*Parophrys vetulus* and *Psettichthys melanostictus*), shiner perch (*Cymatogaster aggregata*), starry flounder (*Platichthys stellatus*), bay gobies (*Lepidogobius lepidus*), and three-spine sticklebacks (*Gasterosteus aculeatus*) (Feldman 2001). Furthermore, fish inhabiting subtidal channels or migrating over treated mudflats with the flood tide may exhibit a marked reduction in brain acetylcholinesterase (AChE) activity. Field studies with caged juvenile English sole (*Pleuronectes vetulus*) indicated that mean brain AChE inhibition was 26% in fish placed on treated mudflats and 24% in fish placed subtidally, maximum individual values approaching 50%. The maximum carbaryl water concentration was 1.2 ppm at the cage sites, while sediment concentrations on treated mudflats were as high as 23 ppm 24 hours following application. In treated mudflats, invertebrates that are a source of food for these fish had carbaryl concentrations as high as 76 ppm. It was estimated that AChE inhibition of up to 50% was possible due to the additive exposure to carbaryl in water and prey items, resulting in temporary impairment of burying behavior and increased exposure to predators (Hulburt *et al.* 1989). Recovery of burying behavior occurred after removal of the exposure.

Several potential nonchemical pest management methods have been identified, including alternative culture techniques, mechanical control, enhancement of shrimp predators, electrofishing, and modification of carbaryl application. Results have shown significant short term impacts to arthropods on a species specific basis (Brooks, 1993). Additional mitigation measures may include alternative carbaryl application techniques that reduce dispersion to nontarget areas, such as direct injection of carbaryl into the sediment. Subsurface injection has shown to be effective in controlling burrowing shrimp and uses 66% less chemical than aerial application (Durfey and Simpson, 1995). Applying a layer of oyster shells (shell pavement) is a promising technique that can reduce ghost shrimp densities under certain conditions, but this approach can be disruptive to the oyster culture and remains untested on a commercial scale. To date, the complexity of the oyster culture and the ecology of the burrowing shrimp has disrupted attempts to develop and adopt practical and cost-effective alternative control methods (Feldman *et al.,* 2000).

Estuarine/Marine Invertebrates

The acute LOC for estuarine/marine invertebrates is exceeded for all five carbaryl use scenarios assessed at maximum label application rates (acute RQs = 1.51 - 48.07), at maximum reported use rates (acute RQs = 1.05 - 40.70), and at "average" rates (acute RQs = 0.79 - 25.44) indicating that some carbaryl uses may pose an acute risk to estuarine/ marine invertebrates inhabiting intertidal zones and estuaries located downstream from treated areas. It is not possible to evaluate chronic risk to estuarine/marine invertebrates at this time due to the unavailability of data.

As for fish, carbaryl applications to control burrowing shrimp in Washington State tidelands is known to represent a significant acute risk to estuarine/marine invertebrates inhabiting treated tideland areas. There may be up to 100% mortality of Dungenese crab (*Cancer magister*) populations following carbaryl applications (Hulburt *et al.* 1989). In addition, the populations of some salmonid arthropod prey species are significantly reduced following application, while other species are more tolerant. Most populations recover within 51 days, but some do not recover (Brooks 1993). Once established, oyster beds do provide an enhanced environment for many plants and invertebrates that grow on the oyster shells or in between them, and which are normally rare or absent in barren mudflats.

Reproduction Effects on Fish

There is information indicating that carbaryl has the potential to adversely affect reproduction in fish. Carlson (1972) reports that when the fathead minnow (*Primephales promelas*) was exposed to 5 concentrations of carbaryl in the 0.008-0.68 mg/l range for 9 months and throughout a life cycle, the 0.68 mg/l (680 ppb) concentration prevented reproduction and decreased survival. At this high concentration, the mean number of eggs per female and the mean number of eggs per spawning were significantly less than for the control group, and no hatching occurred. In addition, the ovaries contained flaccid eggs and appeared to be in a resorptive state. However, this test concentration is higher than the highest peak EECs derived from PRZM/EXAMS, and it is therefore unlikely that fish will be exposed to such high carbaryl levels for extended periods under field conditions.

Ghosh *et al.* (1990) report that serum and pituitary levels of gonadotropic hormone (GtH) and gonadotropin-releasing hormone (GnRH) in *C. punctatus* were significantly reduced by exposure to nonlethal levels (1.66 - 3.73 ppm) of carbaryl in laboratory and paddy field tests, indicating that at these doses carbaryl may cause reproductive effects to fish. It must be pointed out, however, that the test doses selected for this study are one order of magnitude higher than the highest peak concentrations derived from PRZM/EXAMS modeling. The decrease in GnRH levels could indicate constant exposure to elevated levels of estrogen acting through a negative feedback pathway to inhibit GnRH release, and the subsequent release of gonadotropins (Klotz *et al.* 1997). In a related study, freshwater perch (*Anabas testudineus*) were exposed to nonlethal carbaryl levels (1.66 ppm) for 90 days, covering the pre-spawning and spawning phases of the annual reproductive cycle. Plasma and ovarian estrogen levels in treated fish increased significantly until day 15, after which they declined significantly relative to the control, until the end of the experiment, indicating that at short-term exposures nonlethal levels of carbaryl have no inhibitory effect, while long-term exposure has an inhibitory effect on fish reproduction (Choudhury *et al.* 1993). However, this study was also performed at carbaryl concentrations well above the highest concentration modeled for carbaryl (Table 5) and, therefore, does not provide an indication as to potential effects under field conditions.

Endangered Aquatic Species

The endangered species level of concern for freshwater fish is exceeded for three (sweet corn, field corn, and citrus) of five use scenarios modeled and for the citrus scenario at less than maximum label rates. For marine/estuarine fish, the endangered species LOC is met for the citrus scenario only at maximum label rates. The endangered species LOC is exceeded for freshwater and marine/estuarine aquatic invertebrates for all five use scenarios at maximum label, maximum reported, and "average" application rates.

7.0 Hazard and Risk Assessment for Terrestrial Organisms

Hazard Assessment for Terrestrial Organisms

Avian

Carbaryl is slightly toxic to practically nontoxic to avian species on an acute basis. LD_{50} values are greater than 2,000 mg/kg in pheasants, greater than 2,564 mg/kg in mallards, and fall in the 1,000 - 1,790 mg/kg range for a passerine species (rock doves). LD_{50} values as low as 16.2 mg/kg and 56.2 mg/kg, based on simple screening tests, have been reported for the starling and the red-winged blackbird, respectively (Schafer et al., 1983). At a subacute level, carbaryl is categorized as practically nontoxic to birds, with LC_{50} values greater than 5,000 ppm. However, chronic reproduction effects (egg production) from carbaryl exposure have been noted in the mallard duck at the 1000 and 3000 ppm levels (LOAEC = 1000 ppm, NOAEC = 300 ppm). Other reproduction effects, at the 3000 ppm level, include cracked eggs, fertility, embryonic mortality, and hatching success.

According to DeRosa *et al.* (1976), significant amounts of carbaryl were detected in the egg yolks of adult Coturnix quail (*Coturnix coturnix japonica*) following pesticide ingestion, with treatment levels of 20, 40, and 400 ppm resulting in pesticide residues of 1.58, 2.03, and 3.15 ppm, respectively in the egg yolk. In addition, egg production was significantly reduced, although egg viability was not affected, and agonistic behavior decreased in males, while increasing in the females.

The rock dove acute oral LD_{50} of 1000 mg/kg is used to assess risk for granular uses, whereas the quail subacute dietary LD_{50} of >5000 ppm and the mallard duck reproduction NOAEC of 300 ppm are used to assess, respectively, acute and chronic risk for nongranular uses.

Mammalian

With a rat LD_{50} of 301 mg/kg, carbaryl is categorized as moderately toxic to small mammals on an acute oral basis. However, NOAEC and LOAEC values of 80 and 600 ppm, respectively, based on decreased fetal body weights and increased incomplete ossification of multiple bones in the laboratory rat suggest that carbaryl has the potential for chronic effects on small mammals. The rat LD_{50} of 301 mg/kg and a rat NOAEC of 80 ppm are the toxicity endpoints used in the risk assessment for carbaryl.

Insects

Technical carbaryl is highly toxic to bees on an acute contact basis (LD_{50} = 1.3 µg/bee). The topical LD_{50} for alfalfa leaf-cutter bee (*Megachile pacifica = M. rotundata*) is 262.4 µg/g (MRID 05015678: Lee & Brindley, 1974). Nongranular carbaryl formulations can be highly toxic to bees exposed to direct application, i.e. when bees are actively visiting blooming crops or weeds. Residual toxicity varies with the crops and weather conditions. Exposing leafcutting bees (Megachilidae), alkali bees (Halictidae), and honey bees (Apidae) to 24 hr residues from 80% WP carbaryl applied at the rate of 1 lb/acre resulted, respectively, in a 85%, 78%, and 69% mortality rate (Johansen 1972).

Carbaryl is also moderately to highly toxic to predaceous arthropods, including lace bugs (Nabidae) (MRID 05010807), big eyed bugs (Geocoridae: *Geocoris*) (MRID 05010807), lady beetles (Coccinellidae: *Coccinella*, *Cryptolaemus, Hippodamia, Lindorus, Rhodolia, Stethorus*) (MRIDs 05013372, 05003978, 05005640), ground beetles (Carabidae: *Scarites, Pterostichus, Bembidion, Harpalus*) (MRID 05008149), hymenopterous parasitoids (*Aphytis, Metaphycus, Spalangia, Leptomastix*) (MRID 05003978, 05005640), predaceous mites (*Amblyseius, Typhlodromus*) (MRIDs 05004148, 05013359, 05009346), and spiders (MRID 05010807). In laboratory tests, field-weathered carbaryl residues have been shown to kill the parasitic wasp *Aphytis holoxanthus*, a natural enemy of the Florida red scale, for a period of up to 22 days post-treatment under spring conditions in Florida (Rehman et al., 1999).

Terrestrial Plants

Although carbaryl is primarily an insecticide, it can also be used as a fruit thinning agent on apples and pears. However, the product's label cautions that if applied to wet foliage or during periods of high humidity, it may cause injury to tender foliage. The label also cautions against using carbaryl on Boston ivy, Virginia creeper, or maidenhair fern due to potential injury. Several incidents involving injury to vegetable crops (potatoes, tomatoes, cabbage, and broccoli) in New York and Pennsylvania have been reported. Tier I and, if appropriate, Tier II Seed Germination and Seedling Emergence, as well as Vegetative Vigor studies are required.

Risk Assessment for Terrestrial Organisms

To assess acute risk to birds from exposure to nongranular carbaryl, estimated environmental concentrations (EECs) in food items following product application were compared to LC_{50} values. EECs were calculated using three separate sets of usage data: maximum label use rates, maximum reported (based on Doane usage data available for 42 uses) use rates, and "average" use rates (used mainly for comparison purposes). To assess chronic risk to birds, EECs were compared to NOAEC values. To assess acute risk to birds from exposure to granular carbaryl, the number of LD_{50} values per square foot was used as the risk quotient for birds in three separate weight classes (20, 180, and 1000 g). Acute risk to mammals (herbivores/ insectivores and granivores) from exposure to nongranular carbaryl was assessed for three separate body weight and food consumption classes (15g, 35g, and 1000 g mammals and daily food consumption rates equal to 95%, 66%, and 15% of their body weight, respectively) by comparing EECs in food items following product application to LD_{50} values. Chronic risk to mammals was assessed for the same three weight classes by comparing EECs to NOAEC values. To assess exposure to granular carbaryl, the number of LD_{50} values per square foot was used to calculate RQs for mammals in the three weight classes.

Avian Risk

Nongranular Formulations

Carbaryl is slightly to practically nontoxic to avian species on an acute, and practically nontoxic on a subacute basis. However, it has been shown to have chronic reproduction effects (number of eggs produced) to the mallard at 1000 ppm and higher exposure levels (NOAEC = 300 ppm). A detailed analyses of avian risk quotients (RQs) in relation to their corresponding levels of concern (LOCs) is presented in Appendix B.

The avian acute risk level of concern (LOC) is not exceeded for any nongranular carbaryl use at maximum nor less than maximum label application rates. The avian chronic risk LOC is exceeded for almost all (73 of 74) nongranular uses considered at maximum label rates, for 34 of 42 uses at maximum reported rates, and for 39 of 70 uses at "average" rates. (Appendix B, Tables 4, 5a, and 5b). Thus, although no nongranular uses are likely to present an acute risk to birds, most uses are expected to pose a significant chronic risk (*i.e.* reproduction effects) to birds.

Granular Formulations

The avian acute, restricted use, and endangered species LOCs are exceeded (RQs: 0.52 - 4.76) for birds in the 20 g weight class, for all (about 40) granular carbaryl uses. The acute risk LOC is also exceeded (RQ: 0.53) for birds in the 180 g weight class for the trees/ ornamentals, turfgrass, and tick control uses. No acute LOCs are exceeded for birds in the 1000 g weight class for any of the granular carbaryl uses (Appendix B, Table 6). The avian endangered species LOC is exceeded for 20 g and 180 g birds for most uses.

Mammalian Risk

Risk to Herbivores/Insectivores: Nongranular Formulations

Risk Quotients for Herbivores/Insectivores Based on Less than Maximum Label Use Rates

In addition to maximum label use rates, mammalian acute and chronic RQs were also calculated for nongranular carbaryl using QUA average use rates data available for 70 uses (Appendix B, Table 10a) and maximum reported (Doane data) use rates data available for 42 uses (Appendix B, Table 10b).

As summarized in Table 10a, when RQs are based on QUA average rates, the acute risk LOC is exceeded for 63 of the 70 uses (RQs = 0.53 - 4.02), whereas the restricted use LOC is exceeded for 69 uses (not exceeded only for cabbage), and the endangered species LOC is exceeded for all 70 uses. The chronic risk LOC is exceeded for 69 of the 70 uses (RQs: 1.5 - 15.9).

When RQs are calculated using maximum reported application rates, the acute risk LOC is exceeded for 41 of the 42 uses (RQs: 0.60 - 11.36), while the restricted use, endangered species, and chronic (RQs: 1.5 - 45) risk LOCs are exceeded for all 42 uses (Table 10b).

Risk Quotients for Herbivores/Insectivores Based on Maximum Label Use Rates

Carbaryl is moderately toxic to small mammals on an acute oral basis (rat LD_{50} = 301 mg/kg), and has the potential for mammalian chronic effects (LOAEC = 600 ppm , NOAEC = 80 ppm, based on decreased fetal body weights and increased incomplete ossification of multiple bones in the laboratory rat). A detailed analysis of mammalian RQs in relation to their corresponding levels of concern (LOCs) is presented in Appendix B.

Food items: short grass - The mammalian acute risk LOC is exceeded for all registered nongranular carbaryl uses, at maximum label application rates, for small (15 and 35 g) short grass feeders with a daily food consumption equal to 95% and 66% of their body weight, with RQ values ranging from 0.76 to 12.12 and from 0.53 to 8.42, respectively (Appendix B, Table 7). Similarly, the acute risk LOC for 1000 g herbivores with a daily food consumption equal to 15% of their body weight is exceeded for all uses (RQs: 0.56 - 1.91), except rice, sunflower, sugar beets, wheat, millet, flax, pasture, grasses, noncropland, alfalfa, clover, rangeland, and forested areas.

Food items: broadleaf/forage plants and small insects - At maximum label application rates, the acute risk LOC is exceeded for all nongranular carbaryl uses, except rangeland, for 15 g (RQs: 0.80 - 6.82) and 35 g (0.55 - 4.74) small mammals feeding on broadleaf/forage plants and small insects. For 1000 g mammals consuming 15 % of their body weight, the acute risk LOC is reached or exceeded for only the citrus, olives, pome fruits, stone fruits, tree nuts, sweet corn, asparagus, small fruits and berries, and turfgrass uses (RQs: 0.52 - 1.08), although the restricted use and/or the endangered species LOCs are exceeded for most other uses.

Food items: fruits, pods, seeds, and large insects - For small mammals consuming 95% of their body weight in fruits, pods, seeds, and large insects, the acute risk LOC is exceeded for the citrus, olives, tree nuts, sweet corn, turfgrass uses (RQs: 0.62 - 0.76). Most other registered uses (pome and stone fruits, field corn, asparagus, cucurbits, trees and ornamentals, solanaceous crops, sweet potatoes, peanuts, tobacco, leafy vegetables, *Brassica* crops, roots and tubers, sorghum, small fruits and berries), however, exceed the acute restricted use LOC, while rice, sunflower, sugar beets, wheat, millet, flax, pasture, grasses, noncropland, alfalfa, and clover exceed the acute endangered species LOC.

For mammals consuming 66% of their body weight the acute risk LOC is exceeded only for use on citrus in California (RQ: 0.53); the acute restricted use LOC is exceeded for the following uses: citrus, olives, pome and stone fruits, tree nuts, sweet corn, asparagus, solanaceous crops, sweet potatoes, peanuts, tobacco, small fruits, berries, and turfgrass (RQs: 0.22 - 0.49); and the acute endangered species LOC is reached or exceeded for field corn, cucurbits, trees and ornamentals, leafy vegetables, *Brassica* crops, roots and tubers, sorghum, legumes, alfalfa, and clover (RQs: 0.11 - 0.18).

For mammals that consume 15% of their body weight, neither acute risk nor acute restricted use LOC is exceeded for any registered uses, although the acute endangered species LOC is reached or exceeded for a few uses (citrus, olives, tree nuts, sweet corn, and turfgrass), with RQs in the 0.1 - 0.12 range.

Risk to Granivores: Nongranular Uses

Neither the acute risk nor the acute restricted use LOC is exceeded for granivores for any of the nongranular carbaryl uses. However, the acute endangered species LOC is reached or exceeded for the citrus, olives, pome and stone fruits, tree nuts, sweet corn, and turfgrass use sites (RQs: 0.10 - 0.16), as well as for the citrus, olives, tree nuts, sweet corn, and turfgrass use sites (RQs: 0.10 - 0.12), for granivores with daily food consumption equal to 21% and 15% of their body weight, respectively. No acute LOCs are exceeded for granivores which consume daily 3% of their body weight.

Chronic Risk: Nongranular Uses

At maximum label application rates, the mammalian chronic LOC (1) is exceeded for all registered uses of nongranular carbaryl for all food item groups, with chronic RQ values in the 3.0 - 48.0 range (for short grasses), 1.4 - 22.0 range (for tall grasses), and 1.7 - 27.0 range (for broadleaf/forage plants, small insects). The mammalian chronic LOC is exceeded for the fruits/ pods/seeds/large insects food items for the following uses: citrus, olives, pome and stone fruits, tree nuts, field and sweet corn, asparagus, solanaceous vegetable crops, sweet potatoes, peanuts, tobacco, small fruits and berries, and turfgrass (chronic RQs = 1.0 - 3.0). These data are summarized in Appendix B, Table 9.

Risk: Granular Uses

At maximum application rates, RQs exceed the acute risk LOC for 15 g mammals (RQs: 2.26 - 20.71) and 35 g mammals (RQs: 0.97 - 8.87) for all 40 registered granular uses. For the 1000 g mammal category, the acute restricted use LOC is exceeded for the trees/ornamentals, turfgrass, and tick control uses.

Reproduction Effects

Field and laboratory studies conducted in the 1970s, some of them in former Soviet Union countries, suggest that exposure to carbaryl may affect reproduction in mammals. For instance, in a field study undertaken by Smirnov *et al.* (1971), the vegetation around colonies of ground squirrels (*Rhombomys opimus* Licht.) was treated with carbaryl at 0.5 g/m^2 (4.45 lb/acre) within a radius of 15 m. Carbaryl residues in plants around dens and in food stored in dens were, respectively, above 0.03 mg/kg and 0.02 mg/kg four months after treatment. The percentage of lactating females was 5. 9% in the treated area and 31. 6% for control females. In the treated areas, 41. 2% of all females were inactive in mid-May, while 28.9% of females were inactive in the untreated colonies. Rates of fetal resorption were 41.9% in the test group and 1.08% in the control group. The average number of embryos per female was 6 in the treated group and 7. 4 in the control group.

Exposure to a single field application of 0.1-5 kg/ha of carbaryl in areas spanning several climatic zones of the former USSR resulted in adverse effects in lemmings, voles, moles, pikas, and gerbils, including disturbances in spermatogenesis, pathological pregnancy, increased embryonal resorption, increased percentages of infertile females, males with underdeveloped testicles, reduction of the number of embryos per pregnancy and changes in population structures (Krylova *et al.,* 1975). In the year of treatment, carbaryl residues were present in livers (1.4-3 mg/kg), testes (3.6-12.5 mg/kg), uteri (2-5 mg/kg) and embryos (1.9-3.3 mg/kg), as well as in these species' natural food (1.5 mg/kg). Carbaryl was found in grass (0.08 mg/kg) for as long as 2 years after treatment. During the year of treatment, there was a significant reduction of only the mole population in the treated areas, but during the following 1-3 years there were significant reductions in the populations of all five species.

Pomeroy and Barrett (1975) report that a population of cotton rats (*Sigmodon hispidus*) inhabiting a plot that had been treated with a single application of carbaryl had a lower peak population density than in a nontreated, control plot. During winter, reproduction ceased, and the cotton rats lost weight in the treated area, whereas rats in the nontreated area maintained or gained weight. Also, a population of house mice that was present in the study area continued to reproduce in the treated plot, although at a reduced rate, further indicating the potential to disrupt mammal reproduction.

Pregnant dogs treated with carbaryl via diet at 0, 2.0, 5.0, and 12.5 mg/kg/day from day 1 of gestation until their pups were weaned at 6 weeks of age resulted in a slight increase in stillbirths and a slight reduction in survival until weaning, although no teratogenic effects were observed (Anonymous, 1969). Dietary exposure to carbaryl at levels up to 2000 ppm did not affect reproduction in house mice (DeNorscia and Lodge, 1973). According to Gladenko *et al.* (1970), a considerable reduction of fecundity and litter size was observed in rats fed daily 10 mg of carbaryl for 138 days, and pesticide residues were detected in embryos. Narotsky and Kavlock (1995) report that carbaryl fed to pregnant rats showed a slight potential for developmental toxicity. Chapin *et al.* (1997), however, found no changes in sex organ structure or reproductive function of male or female rats treated as juveniles with carbaryl at 0, 6, 12, or 25 mg/kg/day.

Feeding 2 or 20 mg/kg of carbaryl to pregnant rhesus monkeys (*Macacca mulatta*) throughout gestation did not produce teratologic effect, although treatment apparently caused a higher rate of abortion as compared with controls (Dougherty *et al.,* 1971). In a related study, pregnant rhesus monkeys received either 0.2, 2 or 20 mg/kg of carbaryl per day by stomach tube from day 20 to day 28 of gestation. Females were observed during pregnancy, and offspring were followed for one year following birth. None of the pregnant monkeys showed signs of toxicity. There were no statistical differences between controls and monkeys receiving up to 20 milligrams of carbaryl in terms of birth weights, gestation lengths, or infant growth rates. There were no significant differences observed in plasma or red blood cell cholinesterase concentrations. Examination of aborted animals, still births and live infants revealed no teratogenic signs (Dougherty, 1975).

Insects

Although EFED does not assess risk to nontarget insects at present, data from acceptable guideline and nonguideline studies are used to recommend appropriate label precautions. Technical carbaryl is highly toxic to honey bees (LC_{50} = 1.3 - 2.0 ug/ bee) and carbaryl-containing products should be applied only under the conditions specified by the pollinator protection label language. An important factor in determining the degree of carbaryl hazard to honey bees is the formulation type. Certain formulations, such as baits and granulars, present little or no hazard to bees due to the low potential for exposure, whereas other formulations, such as dusts, wettable powders, and flowables may pose a hazard from direct contact as well as from extended residual toxicity.

The honey bee is a beneficial arthropod that plays a major role in pollinating wild plants and crop plants including fruits, vegetables, and herbs. Toxic compounds present in air, soil and water not only can hit the foraging bee, but can also be concentrated and stored in the beehive before being consumed by emerging broods or overwintering bees. Sublethal doses of carbaryl can disturb the reproductive behavior, dispersal behavior, feeding behavior, and locomotion of bees, all of which can lead to disorders in population dynamics.

Carbaryl has often been implicated in bee kills, which is not surprising considering that this chemical is an effective wide-spectrum insecticide with multiple agricultural and urban uses. For instance, carbaryl was one of three insecticides responsible for most of the 114 bee kill incidents reported for Washington State during the 1992-1996 period (Johansen, 1997). The other two chemicals were chlorpyrifos and micro-encapsulated methyl parathion. Similarly, in 1997 the American Beekeeping Federation ranked carbaryl as third in importance among pesticides reported as responsible for most bee mortality incidents in the U.S. (Brandi, 1997). Bee kill incidents involving carbaryl in several states, including North Carolina, South Dakota, and Washington have been reported to the Agency.

Carbaryl, being moderately to highly toxic to a wide range of predaceous and parasitic arthropods, many of which are natural enemies of insects and mites injurious to agriculture, is expected to pose an acute risk to such organisms.

Terrestrial Plants

Although primarily an insecticide/acaricide, carbaryl can have adverse effects in some terrestrial plants. Carbaryl is used as a fruit thinning agent on apples and pears, but precautionary label language cautions that it may cause fruit deformity under certain environmental conditions, and applications to wet foliage or during periods of high humidity may cause injury to tender foliage. Carbaryl may also cause injury to Boston ivy, Virginia creeper, maidenhair fern, and Virginia and sand pines. Plant incidents classified as probable include damage to potatoes, tomatoes, cabbage, broccoli in Pennsylvania and Florida (I009305-001, I010017-016). The registrant should submit a Tier I Seed Germination and Seedling Emergence, as well as Vegetative Vigor Studies. If 25% or greater detrimental effects are found in one or more plant species in the Tier I study, Tier II Seed Germination/Seedling Emergence and Vegetative Vigor studies should be also submitted. Guideline 122-1 is not fulfilled.

Endangered Terrestrial Species

The endangered species LOC for birds is met or exceeded for 72 of 74 nongranular carbaryl uses at maximum label use rates, for 18 of 70 carbaryl uses at QUA average use rates, and for 25 of 42 maximum reported use rates. The endangered species LOC is exceeded for 20 g birds for all granular uses. For 180 g birds it is exceeded for all granular uses, except cucumber, melons, pumpkin, squash, beans, peas, lentils, cowpeas, southern peas, wheat, millet, and sugar beets. For 1000 g birds, the endangered species LOC is reached for the trees and ornamentals, turfgrass, and tick control granular uses.

The endangered species LOC for all three mammal weight categories and the grass/ broadleaf plants/small insects food items is exceeded for all nongranular uses examined, at maximum label rates. At "average" and maximum reported use rates, the endangered species LOC for 15 g mammals feeding on short grass is exceeded for all nongranular uses. At maximum label rates, the endangered species LOC is exceeded for small (15 and 35 g) mammals for all granular uses, whereas for 1000 g mammals, it is exceeded only for the trees/ornamentals, turfgrass, and tick control granular uses.

The endangered species LOC for freshwater fish is exceeded for three (sweet corn, field corn, and citrus) of five use scenarios modeled and for the citrus scenario at less than maximum label rates. For marine/estuarine fish, the endangered species LOC is met for the citrus scenario only at maximum label rates. The endangered species LOC is exceeded for freshwater and marine/estuarine aquatic invertebrates for all five use scenarios at maximum and less than maximum label use rates.

Although no RQs are calculated for insects, considering its toxicity to arthropods and broad-spectrum uses, carbaryl is expected to pose a risk to endangered species of insects and other terrestrial arthropods.

The Agency has developed a program (the "Endangered Species Protection Program") to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that will eliminate the adverse impacts. At present, the program is being implemented on an interim basis as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989), and is providing information to pesticide users to help them protect these species on a voluntary basis. As currently planned, the final program will call for label modifications referring to required limitations on pesticide uses, typically as depicted in county-specific bulletins or by other site-specific mechanisms as specified by state partners. A final program, which may be altered from the interim program, will be described in a future Federal Register notice. The Agency is not imposing label modifications at this time through the RED. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program.

8.0 Summary of Ecological Incident Data

Based on information available in the USEPA Ecological Incident Information System (EIIS), carbaryl does not rank high in the list of pesticides responsible for bird or mammal mortality. Three bird kill incidents, involving blackbirds, ducks, starlings, and grackles in Virginia, New Jersey, and South Carolina have been reported and classified as probable. Likewise, there are only two incidents involving small mammals (grey and ground squirrels, mole, rabbit) in South Carolina and Virginia. On the other hand, numerous bee kill incidents have been recorded for carbaryl in several states, including North Carolina, South Dakota, and Washington. In addition, several incidents on vegetable crops, including damage to potatoes, tomatoes, cabbage, broccoli classified as probable, have been recorded in New York, Pennsylvania, and Florida (I009305-001, I010017-016).

The number of documented incidents in the EIIS is believed to be a small fraction of the total mortality caused by pesticides. Mortality incidents must be seen, reported, investigated and the information submitted to EPA in order to be recorded in the data base (the states submit this information on a voluntary basis). Often incidents may not be noted because the carcasses either decayed in the field, were removed by scavengers, or were located in out-of-the-way or hard-to-see locations. For example, poisoned birds may fly off-site before dying, some species of fish may sink and the bodies of young fish can quickly decompose in the environment prior to any notice of a problem. An incident may also go unreported because the finder may not be aware of the significance of the issue or may not know the appropriate authorities for an investigation. Furthermore, limited resources may hamper investigations and preclude any confirmatory analysis of tissue and residues.

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Appendix A: Refined Water Memo

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

PC Code:056801
DP Bar Code: D267276
DATE: July 23, 2001

MEMORANDUM

SUBJECT: Refined Estimated Environmental Concentrations for Carbaryl

FROM: E. Laurence Libelo, Ph.D., Environmental Engineer
Environmental Risk Branch IV
Environmental Fate and Effects Division (7507C)

THROUGH: Elizabeth Behl, Chief
Environmental Risk Branch IV, EFED (7507C)

TO: Anthony E. Britten, Chemical Review Manager
Betty Shackleford, Branch Chief
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Special Review and Reregistration Division (7508C)

Virginia Dobozy, Ph.D., HED/RRBI

This memo presents refined surface water and groundwater Estimated Environmental Concentrations (EECs) for use in calculating human exposure to carbaryl. These values were determined using available monitoring data, modeling with PRZM/EXAMS for surface water, and SCI-GROW for groundwater. EEC values are shown in Table 1. Because of uncertainties in available monitoring data EFED recommends using modeling results in assessing Carbaryl risks.

Background:

Chemical characteristics and available monitoring data indicate that carbaryl has the potential to enter surface water via leaching and runoff under certain conditions and has limited potential to leach to ground water. Carbaryl tends not to partition to soil, aquifer solids, or sediment. Once the compound has entered surface water, it may be degraded by chemical and biological processes. Abiotic degradation by photolysis ($t_{1/2}$ = 21 days) and hydrolysis in alkaline ($t_{1/2}$ = 3.2 hours at pH 9) and neutral ($t_{1/2}$ = 12 days at pH 7) waters result in fairly rapid degradation in most aqueous environments. Microbially mediated processes also contribute to fairly rapid degradation of the parent to 1-naphthol and CO_2. Aerobic aquatic, soil aerobic and anaerobic metabolism studies ($t_{1/2}$ = 5, 4, and 72 days respectively) suggest that the compound is broken down by a variety of metabolic processes.

Under certain conditions carbaryl can be expected to persist in the environment. Under low pH conditions the compound is stable to hydrolysis. In anaerobic environments metabolism is fairly slow ($t_{\frac{1}{2}}$ = 72 days). This suggests that carbaryl may leach to ground water and persist in some aquifers.

Monitoring studies show that carbaryl is a commonly detected contaminant in surface water. Carbaryl, at typically low concentrations, is found in greater than 20 % of surface samples with concentrations up to 7 ppb. Carbaryl is generally not widely detected in groundwater monitoring studies though some studies have found concentrations of up to several hundred ppb. Concentrations as high as 610 µg/L have been detected in one case but typical groundwater concentrations are much lower. NAWQA studies have found that about 1 % of groundwater samples have measurable levels (> 0.003 : g/L) of carbaryl, with a maximum concentration of 0.02 µg/L. Targeted studies designed to measure carbaryl in groundwater are not available.

Based on chemical properties, existing monitoring data and computer simulation estimates of carbaryl contamination that can be expected in surface water and groundwater as a result of normal agricultural practices have been determined. Carbaryl is commonly found in surface water, and can be expected to contaminate drinking water derived from surface water bodies. Targeted and non-targeted studies regularly detect carbaryl in low concentrations, typically below 1 µg/L. Carbaryl use in urban and suburban areas results in higher frequency of surface water contamination. Monitoring data suggest that carbaryl concentrations resulting from non-agricultural uses are higher then from agricultural uses. However, at this time EFED does not have methods for evaluating EECs from non-agricultural uses.

Carbaryl is not widely detected in groundwater studies. For drinking water derived from groundwater, the acute and chronic EEC value of 0.8 µg/L is based on modeling using SCI-GROW. It must be noted that carbaryl has an aerobic metabolism half-life (4 days) which is significantly outside the range of values for which SCI-GROW may be valid (17-1000 days). Because of this there is significant uncertainty in the SCI-GROW value. EFED currently does not have more advanced groundwater models, and targeted studies specifically designed to evaluate the potential for carbaryl to move to groundwater are not available.

Because of its chemical structure carbaryl is somewhat difficult to quantify by gas chromatography. Older studies using GC or GC/MS generally have poor recovery and quantitation limits. Because of this difficulty in analysis the actual concentration of carbaryl in groundwater and surface waters may be higher than reported. More recent studies using HPLC/MS should provide better data on the true extent and magnitude of water contamination from the use of carbaryl.

Surface Water Modeling

Surface water EECs derived from computer modeling are higher than generally seen in monitoring studies. Carbaryl is often detected in surface water, and it is very unlikely that monitoring data represents actual maximum concentrations or that all occurrences have been sampled. Because Carbaryl is fairly reactive in the environment it is difficult to design a sampling program that can identify the peak concentrations. Therefore EFED recommends using modeling data in human health risk assessment.

Modeling to support the assessment of drinking water in the human health risk assessment was done for five crop scenario: Florida citrus, Ohio sweet corn and field corn, Oregon apples and Minnesota sugar beets. Three different application rate scenarios were used in modeling: the maximum allowed on the label for the specific crop, an "average" rate, and the maximum rate reported to actually be used[6]. EECs were calculated using The Pesticide Root Zone Model version 3.12 (PRZM) (Carsel *et al.*, 1997) and EXAMS 2.97.5 (Exposure Analysis Modeling System) (Burns, 1997). PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field and EXAMS estimates environmental fate and transport of pesticides in surface water. Weather and agricultural practices are simulated over 36 years so that the 10-year exceedance probability at the site can be estimated. A partial list of input parameters for the PRZM/EXAMS modeling are given in Table 2. The values generated by the models were multiplied by a default percent crop area factor (PCA) which accounts for the fact that is unlikely for any basin to be completely planted to agricultural crops. For human health assessment, simulations were done using the Index Reservoir scenario in Exams. The Index Reservoir and PCA are described in Jones *et al.*, 2000. The EEC's for the five scenarios simulated are shown in Table 1. Input files for PRZM/EXAMS modeling are attached.

Corn:

Runoff from use on sweet and field corn was modeled using a Ohio corn scenario located in the Scioto River valley of Central Ohio. The soil is a Cardington silt loam, a fine, illitic, mesic Aquic Hapludalfs in MLRA M-111. The Cardington silt loam is a very deep, moderately well drained soil formed in loamy till of medium lime content. Soils are located on 0-15 percent

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6 **Maximum** is the highest application rate allowed according to the label for the specific crop

"Average" is the average rate as determined by OPP/BEAD and reported in the a memo titled Quantitative Usage Analysis for Carbaryl, prepared July 21, 1998 by Frank Hernandez, OPP/BEAD

Maximum used is the highest rate of application that is actually reported to be used based on OPP/BEAD analysis of Doanes survey data convex SE facing slopes on summits, shoulders, and back slopes on Wisconsin Age ground and end moraines. Permeability is slow and runoff is negligible to very high. An intermittent perched water table is present between 1-2 feet from November and April in most years. The MAP is 36 inches and the MAT is 51ºF. Most areas are cultivated. Major crops are corn, soybeans, small grains, and hay. Some areas are in pasture. The soil is characterized as Group C hydrologic soil. The soil distribution includes Central and North-Central Ohio. The series is of large extent, approximately 250,000 acres. The series was established in Licking County Ohio in 1930. A PCA of 0.46 was used to correct calculated values for percent area cropped.

Apples:

Runoff from application on apples was modeled using a standard input scenario for an orchard in Washington County, Oregon. The soil at the site is a Cornelius silt loam soil, a fine-silty, mixed, mesic Ultic Haploxeralf on a 15% slope in MLRA 2. Seventy-six acres of pears and 238 acres of apples were grown in Washington County in 1987 (US Department of Commerce, 1989b). The weather data is from weather station W24232 in Salem, Oregon. The weather data file is also part of the PIRANHA shell, and is used to represent the weather for MLRA 2. The site was selected to represent orchards in the western United States that are reasonable likely to result in high exposures to aquatic organisms.

The pond used the standard Richard Lee pond that is distributed with EXAMS modified for the Index Reservoir. Additional adjustments were made to the standard pond by changing the water temperature to that which was more appropriate for the region being simulated. The temperature in the pond each month was set to the average monthly air temperature over all 36 years calculated from the meteorological file that was used in the simulation. The default PCA of 0.87 was used.

Sugar beets:

Runoff from application on sugar beets was modeled using a standard scenario modified for the Index Reservoir in Polk Co. MN. MN has the highest sugar beet acreage and Polk Co. is the highest in the state. The soil at the site is Bearden silty clay loam, a benchmark, hydrologic group C soil with about 800K mapped acres in MLRA 56. The chemical was applied is two aerial applications of 1.5 lb a.i. per acre 14 days apart. Application timing information provided by the University of Minnesota Agricultural Extension Service, Polk County, MN, EFED does not have a PCA for sugar beets so the default value of 0.87 was used.

Citrus

Use on citrus was modeled using the EFED standard citrus scenario in Oceola County, Florida. The soil is a Adamsville sand, a hyperthermic, uncoated Aquic Quartzipsamment in MLRA 156A. The Adamsville sand is a somewhat poorly drained, rapidly permeable soil that formed in thick sandy marine sediments occurring in Central and Southern Florida on slopes of 0-5 percent. The soil is typical of soils used either for rangeland or citrus production.

Adamsville sand ranges from a Hydrologic Group A soil to a Hydrologic Group C soil, depending on the water table. For the purpose of this modeling, EFED assumed the curve numbers from the PIC of the Adamsville sand as a Group C soil. The default PCA of 0.87 was used.

EECs varied greatly depending on the geographic location, crop and application rate. Calculated EECs range up to about 500 µg/L. The maximum calculated EEC resulted from use on citrus in Florida. Modeling "average" and maximum reported use rates gave EEC values generally 40-60% lower than calculated with maximum rate. EECs calculated by modeling are slightly higher than concentrations observed in monitoring data. Because most available monitoring data is not from targeted studies and is limited spatially and temporally it is not reasonable to expect that it represents the maximum environmental concentrations that exist. Therefore modeling results probably are a better estimate of actual concentrations that may occur in the environment.

Table 1. Carbaryl Drinking Water EECs

Crop		Number of Applications per Year	Pounds A.I. per application	Surface Water Acute (ppb) (1 in 10 year peak single day concentration)	Surface Water Chronic (ppb) (1 in 10 year annual average concentration)
Sweet Corn (OH) (PCA = 0.46)	Maximum[1]	8	2	37	3.2
	Average[2]	2	3.4	45	2.2
	Maximum[3] Reported	3	1	15	0.9
Field Corn (OH) (PCA = 0.46)	Maximum[1]	4	2	30	2.1
	Average[2]	2	1	13	0.6
	Maximum[3] Reported	2	1.5	20	1
Apples (OR) (PCA = 0.87)	Maximum[1]	5	2	144	9
	Average[2]	2	1.2	12	0.7
	Maximum[3] Reported	2	1.6	25	1
Sugar Beets (MN) (PCA = 0.87)	Maximum[1]	2	1.5	19	2
	Average[2]	1	1.5	12	1.1
	Maximum[3] Reported	1	1.2	9	0.9
Citrus (FL) (PCA = 0.87)	Maximum[1]	4	5	494	28
	Average[2]	2	3.4	246	11
	Maximum[3] Reported	3	4.26	411	16
Surface Water Monitoring				5.5 (Maximum Observed Concentration)	
Groundwater (SCI-GROW)	Maximum[1]	5	4	0.8	0.8
Groundwater (NAWQA Monitoring Data)				0.02	0.02

[1] Maximum application rate on label
[2] Average application rate from Quantitative Usage Analysis for Carbaryl, prepared July 21, 1998 by Frank Hernandez, OPP/BEAD
[3] Maximum rate of application reported in DoaneS survey data

Surface Water Monitoring

Carbaryl is widely detected in surface waters in non-targeted and targeted monitoring studies. Observed concentrations are generally low (> 0.5 : g/L). Carbaryl is not very persistent in most surface water conditions suggesting that the wide spread occurrence is a result of its extensive use in a variety of applications. Because of limitation in the analytical methods used there is some question as to the accuracy of carbaryl analysis. Poor analytical methods probably have resulted in lower detection rates and lower concentrations than actually present.

NAWQA

Carbaryl is second most widely detected incesticide (after diazanon) the USGS NAWQA program (http://water.usgs.gov/nawqa/nawqa_home.html). Carbaryl was detected in 46% of 36 NAWQA study units between 1991 and 1998. The reported concentrations are believed to be reliable detections but have greater than average uncertainty in quantification. Carbaryl analytical results are fairly poor, with a typical mean percent recovery of 24% (F = 15) in laboratory quality control samples, and a method detection limit (MDL) of 0.003 ug/L. This suggests that the reported values do not represent the maximum concentrations that exist, and that surface water contamination may be more widespread than the data show.

Out of 5220 surface water samples analyzed 1082, or about 21 percent, were reported as having detections greater than the MDL. The maximum reported concentration was 5.5 µg/L. For samples with positive detections the mean concentration was 0.11 : g/L, with a standard deviation of 0.43 : g/L. A significant portion of the total carbaryl applied was transported to streams. In areas with high agricultural use the load measured in surface waters was relatively consistent across the country at about 0.1 percent of the amount used in the basins (Larson *et al.*, 1999) http://water.wr.usgs.gov/pnsp/rep/wrir984222/load.html. The estimated annual carbaryl use on in agricultural applications is about 4 million pounds suggesting that 400,000 pounds are delivered each year to the nations streams draining agricultural areas.

Streams draining urban areas showed more frequent detections and higher concentrations than streams draining agricultural or mixed land use areas. For example Kimbrough and Litke (1996) reported that, in the South Platte River Basin Study Unit, between April and December of 1993, carbaryl was detected in 14 urban drainage samples and 6 agricultural drainage samples. Carbaryl had the highest concentration of the four insecticides analyzed with a maximum concentration of 2.5 : g/L in the urban basin and 1.5 : g/L in the agricultural basin (http://webserver.cr.usgs.gov/nawqa/splt/meetings/KIMB1.html). In the South-Central Texas Study Unit carbaryl was detected in 12% of streams draining agricultural areas and 52 % draining urban areas (Bush *et al.*, 2000) http://water.usgs.gov/pubs/circ/circ1212/.

Registrant Monitoring Study

Aventis Crop Science submitted interim results of an on-going surface water monitoring study. Carbaryl residues in surface water were measured at drinking water facilities in areas believed to have high agricultural and residential use (MRID 45116201). In this study 16 sites were in agricultural areas and 4 in areas draining suburban areas. Samples of raw water were collected at municipal water treatment facilities for 8-12 months. When raw water showed positive detections for carbaryl, finished water samples collected at the same time were analyzed. Samples were collected weekly during periods suspected of being "high risk" and monthly the rest of the year in agricultural areas. Suburban sites were sampled weekly.

In this study carbaryl was analyzed by HPLC/MS with a limit of detection of 0.002 ppb and a limit of quantitation (LOQ) of 0.030 ppb. Most carbaryl detections in this study were below the LOQ. In raw water samples from suburban sites detectable residues in raw water ranged from 0.002 to 0.023 ppb. 11 out of 40 raw water samples from Sweetwater Creek, the source of water for the East Port facility in Douglas, GA had detectable levels ranging from 0.002 to 0.018 ppb. One out of 46 samples from Joe Pool Lake, Ellis Texas had a detection at 0.014 ppb. Jorden Lake in Cary, NC had 2 detections out of 44 samples (0.004 and 0.003 ppb). 11 out of 40 samples from the Cahaba River in Birmingham AL had detections ranging from 0.002 to 0.023 ppb. Finished water sampled from suburban areas were all below the detection limit.

In samples from agricultural sites 9 out of 15 water sources had some detectable level of carbaryl. The detections were generally at low levels, with one of about 0.16 ppb and one of 0.031. The rest were below the level of quantitation (<0.03 ppb). Samples from finished water were generally lower than raw water, though it appears that raw and finished water sampling did not sample the same mass of water. Therefore, the data can not be used to evaluate the effectiveness of water treatment on carbaryl. Because the samples were collected at the same time, the water exiting the treatment plant was temporally different than the water entering and represent different, independent, parcels of water. In several cases finished water had higher concentrations than raw water, and finished water had detectable carbaryl when the raw did not. The highest concentration measured was in finished water (0.16 ppb). Raw water sampled at the same time had much lower concentration (0.010). This illustrates that carbaryl contamination is transient, and that it is unlikely that any but the most intensive sampling would ever detect the actual peak concentration. That, and the limited number of sites sampled, limit the usefulness of this study. Non-targeted monitoring, such as the NAWQA program, has shown that much higher concentrations occur indicating that this study, while useful, can not be used to describe the overall distribution of concentrations that occur throughout the entire use area. This study does not provide sufficient information to allow estimation of actual peak and mean concentrations that actually occur in all use areas. The highest concentration values measured in this study are close to the average values seen in other, non-targeted, studies.

Only limited information was submitted on sampling site selection and how the sites relate to the overall distribution of use areas. Home and garden sites were selected downstream of urban/suburban areas that were believed to have high use based on county scale sales data. Agricultural sites were selected based on county scale sales data, and are believed to be in "major use counties." This study is still ongoing and only interim study results have been submitted. Additional information is needed to evaluate the study results. Additionally, an analysis of how the selected sites relate to the nationwide distribution of use areas is required. This should include an explanation of why this study did not observe concentrations as high as those found in other, non-targeted studies, and how the results of this study can be related to concentrations that occur throughout the country. Based on the interim data submitted it appears that this study measured concentrations similar to those observed in non-targeted studies and did not capture high end or peak values. This study appears to be well designed though limited but until additional information is submitted it is not possible to use the interim results for more then to reinforce the inferences drawn from non-targeted study data.

STORET

The EPA STORET database (was queried on May 12, 1999 for reports of measurements of carbaryl in surface water. The database contained 8048 records indicating that analysis was done for carbaryl. Out of these 432 reported concentrations above the detection limits. The maximum value reported was 5.5 µg/L. Of the reported detections 18 were above 1 ppb. The data is the STORET database is used to give a general indication of the occurrence pattern only. Lack of QA/QC and analytical methodology limitations limit the usefulness of the STORET data. However, reported detections of carbaryl suggest that the compound is infrequently detected in surface water and at low levels.

Groundwater

Available evidence from valid scientific studies show that carbaryl has a limited potential to leach to ground water, and as a result of normal agricultural use, detections of carbaryl residues have been reported in groundwater from several states. As reported in the U.S. EPA. Pesticides in Groundwater Database (Jacoby *et al.*, 1992) carbaryl was detected in 0.4% of wells sampled. Carbaryl was detected in California (2 out of 1433 wells), Missouri (11 out of 325 wells), New York (69 out of 21027 wells) Rhode Island (13 out of 830 wells) and Virginia (11 out of 138 wells). The maximum concentration detected was 610 µg/L in NY, though typically the measured concentrations were significantly lower.

The EPA STORET database was queried on May 12, 1999 for reports of measurements of carbaryl in groundwater. The database contained 9389 records indicating that analysis was done for carbaryl. Out of these only 4 reported concentrations above the detection limits. These analyses were all from one well in Cleveland, OK in 1988. The 4 reported concentrations were between 0.8 and 1 ppb.

Carbaryl was detected at greater than the detection limit (0.003 µg/L) in 1.1 % of groundwater samples from 1034 sites across the U.S. by U.S.G.S. NAWQA program. The maximum observed concentration was 0.021 µg/L. Detections were from mainly from three use sites: wheat (5.8 % of well samples from wheat land use), orchards and vineyards (1.7 % of well samples from orchard and vineyard land use), and urban (1.8% of urban groundwater samples). Limitations in analytical methodology (described elsewhere) apply to groundwater sample analysis also suggesting that there actual maximum concentrations and extent of contamination may be significantly higher. Data on pesticides in groundwater were reviewed by Kolpin *et al.* (1998) and updated information is available at: http://water.wr.usgs.gov/pnsp/ja/est32/.

For drinking water derived from groundwater an acute and chronic EEC value of 0.8 µg/L should be used based on modeling using SCIGROW. Carbaryl is not frequently detected in groundwater monitoring studies. However, targeted studies specifically designed to evaluate the potential for carbaryl to move to groundwater are not available. SCI-GROW is used to calculate a groundwater screening exposure value to be used in determining the potential risk to human health from drinking water contaminated by use of pesticides. In the case of Carbaryl the chemical properties of the compound are outside the range of values for which SCI-GROW was developed. The EEC value calculated using SCI-GROW should therefore be used with caution since it may significantly underestimate possible groundwater concentrations. SCI-GROW input parameters are shown in Table 2 and a copy of the output is attached..

Water Treatment Effects

The Office of Pesticide Programs has completed a review of the effects of drinking water treatment on pesticides in water (http://www.epa.gov/scipoly/sap/2000/september/sept00 sap__ dw 0907.pdf). This review indicates that standard drinking water treatment, consisting of flocculation/sedimentation and filtration does not substantially affect concentrations of pesticides in drinking water. Evidence suggests that carbaryl does not react with chlorine or hypoclorite disinfection products in water treatment but is rapidly degraded ($T_{1/2}$ = too rapid to measure) by ozone (Mason *et al.*, 1990).

Table 2. PRZM/EXAMS environmental fate input parameters for Carbaryl

Parameter	Value	Data source
Molecular Weight	201.22	
Solubility	32 mg/L (@20°C)	Suntio, *et al.*, 1988
Vapor Pressure (torr)	1.36 10^{-6} @ 25° C	Ferrira and Seiber, 1981
Henry's Law Constant	1.28 x 10^{-8}	Suntio, *et al.* 1988
Hydrolysis Half-life pH 5 pH 7 pH 9	 stable stable 5 hours	MRID 00163847 44759301
Soil Photolysis Half-life (days)	stable	no valid data submitted
Aquatic Photolysis Half-life (days)	21 days	MRID 41982603
Aerobic Soil Metabolism Half-life	4.0 days (n=1 so use 3x)	MRID 42785101
Aerobic Aquatic Metabolism Half-life	4.9 days (n = 1 so use 3x)	MRID 43143401
Anaerobic Aquatic Metabolism Half-life	72.2 days	MRID 42785102
Soil-Water Partitioning Coefficient K_{ads} (K_{oc})	1.74 (207) sandy loam 2.0 (249) clay loam 3.0 (211) silt loam 3.5 (177) silty clay loam (K_{oc} = 211 for SCIGROW)	MRID 43259301

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APPENDIX A1: PRZM Input Files

Maximum Application Rate Ohio Sweet Corn, Index Reservoir

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*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted 3/30/2000
***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00
*** Manning's N values for cornstalk residue, fallow surface, 1 ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami; brookston;
glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063; Ground spray:
0.064 ***
*** Application efficiency: 0.95 aerial; 0.99 spray blast and ground spray ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50   172.8    5.80       3    6.00   600.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00  100.00
*** - RECORD 9A ***
       1       3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
  160558  260958  111058       1
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
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  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Application: aerial Application  8 apps @ 2 lb a.i./acre
*** - RECORD 13 ***
     288       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days; AnSM T1/2 = 24
days
*** - RECORD 16 ***
  300448  0 2 0.00  2.24 0.95 0.16
  140548  0 2 0.00  2.24 0.95 0.16
  280548  0 2 0.00  2.24 0.95 0.16
  110648  0 2 0.00  2.24 0.95 0.16
  250648  0 2 0.00  2.24 0.95 0.16
  090748  0 2 0.00  2.24 0.95 0.16
  230748  0 2 0.00  2.24 0.95 0.16
  060848  0 2 0.00  2.24 0.95 0.16
  300449  0 2 0.00  2.24 0.95 0.16
  140549  0 2 0.00  2.24 0.95 0.16
  280549  0 2 0.00  2.24 0.95 0.16
  110649  0 2 0.00  2.24 0.95 0.16
  250649  0 2 0.00  2.24 0.95 0.16
  090749  0 2 0.00  2.24 0.95 0.16
  230749  0 2 0.00  2.24 0.95 0.16
  060849  0 2 0.00  2.24 0.95 0.16
  300450  0 2 0.00  2.24 0.95 0.16
  140550  0 2 0.00  2.24 0.95 0.16
  280550  0 2 0.00  2.24 0.95 0.16
  110650  0 2 0.00  2.24 0.95 0.16
  250650  0 2 0.00  2.24 0.95 0.16
  090750  0 2 0.00  2.24 0.95 0.16
  230750  0 2 0.00  2.24 0.95 0.16
  060850  0 2 0.00  2.24 0.95 0.16
  300451  0 2 0.00  2.24 0.95 0.16
  140551  0 2 0.00  2.24 0.95 0.16
  280551  0 2 0.00  2.24 0.95 0.16
  110651  0 2 0.00  2.24 0.95 0.16
  250651  0 2 0.00  2.24 0.95 0.16
  090751  0 2 0.00  2.24 0.95 0.16
  230751  0 2 0.00  2.24 0.95 0.16
  060851  0 2 0.00  2.24 0.95 0.16
  300452  0 2 0.00  2.24 0.95 0.16
  140552  0 2 0.00  2.24 0.95 0.16
  280552  0 2 0.00  2.24 0.95 0.16
  110652  0 2 0.00  2.24 0.95 0.16
  250652  0 2 0.00  2.24 0.95 0.16
  090752  0 2 0.00  2.24 0.95 0.16
  230752  0 2 0.00  2.24 0.95 0.16
```

060852	0	2	0.00	2.24	0.95	0.16
300453	0	2	0.00	2.24	0.95	0.16
140553	0	2	0.00	2.24	0.95	0.16
280553	0	2	0.00	2.24	0.95	0.16
110653	0	2	0.00	2.24	0.95	0.16
250653	0	2	0.00	2.24	0.95	0.16
090753	0	2	0.00	2.24	0.95	0.16
230753	0	2	0.00	2.24	0.95	0.16
060853	0	2	0.00	2.24	0.95	0.16
300454	0	2	0.00	2.24	0.95	0.16
140554	0	2	0.00	2.24	0.95	0.16
280554	0	2	0.00	2.24	0.95	0.16
110654	0	2	0.00	2.24	0.95	0.16
250654	0	2	0.00	2.24	0.95	0.16
090754	0	2	0.00	2.24	0.95	0.16
230754	0	2	0.00	2.24	0.95	0.16
060854	0	2	0.00	2.24	0.95	0.16
300455	0	2	0.00	2.24	0.95	0.16
140555	0	2	0.00	2.24	0.95	0.16
280555	0	2	0.00	2.24	0.95	0.16
110655	0	2	0.00	2.24	0.95	0.16
250655	0	2	0.00	2.24	0.95	0.16
090755	0	2	0.00	2.24	0.95	0.16
230755	0	2	0.00	2.24	0.95	0.16
060855	0	2	0.00	2.24	0.95	0.16
300456	0	2	0.00	2.24	0.95	0.16
140556	0	2	0.00	2.24	0.95	0.16
280556	0	2	0.00	2.24	0.95	0.16
110656	0	2	0.00	2.24	0.95	0.16
250656	0	2	0.00	2.24	0.95	0.16
090756	0	2	0.00	2.24	0.95	0.16
230756	0	2	0.00	2.24	0.95	0.16
060856	0	2	0.00	2.24	0.95	0.16
300457	0	2	0.00	2.24	0.95	0.16
140557	0	2	0.00	2.24	0.95	0.16
280557	0	2	0.00	2.24	0.95	0.16
110657	0	2	0.00	2.24	0.95	0.16
250657	0	2	0.00	2.24	0.95	0.16
090757	0	2	0.00	2.24	0.95	0.16
230757	0	2	0.00	2.24	0.95	0.16
060857	0	2	0.00	2.24	0.95	0.16
300458	0	2	0.00	2.24	0.95	0.16
140558	0	2	0.00	2.24	0.95	0.16
280558	0	2	0.00	2.24	0.95	0.16
110658	0	2	0.00	2.24	0.95	0.16
250658	0	2	0.00	2.24	0.95	0.16
090758	0	2	0.00	2.24	0.95	0.16
230758	0	2	0.00	2.24	0.95	0.16
060858	0	2	0.00	2.24	0.95	0.16
300459	0	2	0.00	2.24	0.95	0.16
140559	0	2	0.00	2.24	0.95	0.16
280559	0	2	0.00	2.24	0.95	0.16
110659	0	2	0.00	2.24	0.95	0.16
250659	0	2	0.00	2.24	0.95	0.16
090759	0	2	0.00	2.24	0.95	0.16
230759	0	2	0.00	2.24	0.95	0.16
060859	0	2	0.00	2.24	0.95	0.16
300460	0	2	0.00	2.24	0.95	0.16
140560	0	2	0.00	2.24	0.95	0.16
280560	0	2	0.00	2.24	0.95	0.16
110660	0	2	0.00	2.24	0.95	0.16

250660	0	2	0.00	2.24	0.95	0.16
090760	0	2	0.00	2.24	0.95	0.16
230760	0	2	0.00	2.24	0.95	0.16
060860	0	2	0.00	2.24	0.95	0.16
300461	0	2	0.00	2.24	0.95	0.16
140561	0	2	0.00	2.24	0.95	0.16
280561	0	2	0.00	2.24	0.95	0.16
110661	0	2	0.00	2.24	0.95	0.16
250661	0	2	0.00	2.24	0.95	0.16
090761	0	2	0.00	2.24	0.95	0.16
230761	0	2	0.00	2.24	0.95	0.16
060861	0	2	0.00	2.24	0.95	0.16
300462	0	2	0.00	2.24	0.95	0.16
140562	0	2	0.00	2.24	0.95	0.16
280562	0	2	0.00	2.24	0.95	0.16
110662	0	2	0.00	2.24	0.95	0.16
250662	0	2	0.00	2.24	0.95	0.16
090762	0	2	0.00	2.24	0.95	0.16
230762	0	2	0.00	2.24	0.95	0.16
060862	0	2	0.00	2.24	0.95	0.16
300463	0	2	0.00	2.24	0.95	0.16
140563	0	2	0.00	2.24	0.95	0.16
280563	0	2	0.00	2.24	0.95	0.16
110663	0	2	0.00	2.24	0.95	0.16
250663	0	2	0.00	2.24	0.95	0.16
090763	0	2	0.00	2.24	0.95	0.16
230763	0	2	0.00	2.24	0.95	0.16
060863	0	2	0.00	2.24	0.95	0.16
300464	0	2	0.00	2.24	0.95	0.16
140564	0	2	0.00	2.24	0.95	0.16
280564	0	2	0.00	2.24	0.95	0.16
110664	0	2	0.00	2.24	0.95	0.16
250664	0	2	0.00	2.24	0.95	0.16
090764	0	2	0.00	2.24	0.95	0.16
230764	0	2	0.00	2.24	0.95	0.16
060864	0	2	0.00	2.24	0.95	0.16
300465	0	2	0.00	2.24	0.95	0.16
140565	0	2	0.00	2.24	0.95	0.16
280565	0	2	0.00	2.24	0.95	0.16
110665	0	2	0.00	2.24	0.95	0.16
250665	0	2	0.00	2.24	0.95	0.16
090765	0	2	0.00	2.24	0.95	0.16
230765	0	2	0.00	2.24	0.95	0.16
060865	0	2	0.00	2.24	0.95	0.16
300466	0	2	0.00	2.24	0.95	0.16
140566	0	2	0.00	2.24	0.95	0.16
280566	0	2	0.00	2.24	0.95	0.16
110666	0	2	0.00	2.24	0.95	0.16
250666	0	2	0.00	2.24	0.95	0.16
090766	0	2	0.00	2.24	0.95	0.16
230766	0	2	0.00	2.24	0.95	0.16
060866	0	2	0.00	2.24	0.95	0.16
300467	0	2	0.00	2.24	0.95	0.16
140567	0	2	0.00	2.24	0.95	0.16
280567	0	2	0.00	2.24	0.95	0.16
110667	0	2	0.00	2.24	0.95	0.16
250667	0	2	0.00	2.24	0.95	0.16
090767	0	2	0.00	2.24	0.95	0.16
230767	0	2	0.00	2.24	0.95	0.16
060867	0	2	0.00	2.24	0.95	0.16
300468	0	2	0.00	2.24	0.95	0.16

140568	0	2	0.00	2.24	0.95	0.16
280568	0	2	0.00	2.24	0.95	0.16
110668	0	2	0.00	2.24	0.95	0.16
250668	0	2	0.00	2.24	0.95	0.16
090768	0	2	0.00	2.24	0.95	0.16
230768	0	2	0.00	2.24	0.95	0.16
060868	0	2	0.00	2.24	0.95	0.16
300469	0	2	0.00	2.24	0.95	0.16
140569	0	2	0.00	2.24	0.95	0.16
280569	0	2	0.00	2.24	0.95	0.16
110669	0	2	0.00	2.24	0.95	0.16
250669	0	2	0.00	2.24	0.95	0.16
090769	0	2	0.00	2.24	0.95	0.16
230769	0	2	0.00	2.24	0.95	0.16
060869	0	2	0.00	2.24	0.95	0.16
300470	0	2	0.00	2.24	0.95	0.16
140570	0	2	0.00	2.24	0.95	0.16
280570	0	2	0.00	2.24	0.95	0.16
110670	0	2	0.00	2.24	0.95	0.16
250670	0	2	0.00	2.24	0.95	0.16
090770	0	2	0.00	2.24	0.95	0.16
230770	0	2	0.00	2.24	0.95	0.16
060870	0	2	0.00	2.24	0.95	0.16
300471	0	2	0.00	2.24	0.95	0.16
140571	0	2	0.00	2.24	0.95	0.16
280571	0	2	0.00	2.24	0.95	0.16
110671	0	2	0.00	2.24	0.95	0.16
250671	0	2	0.00	2.24	0.95	0.16
090771	0	2	0.00	2.24	0.95	0.16
230771	0	2	0.00	2.24	0.95	0.16
060871	0	2	0.00	2.24	0.95	0.16
300472	0	2	0.00	2.24	0.95	0.16
140572	0	2	0.00	2.24	0.95	0.16
280572	0	2	0.00	2.24	0.95	0.16
110672	0	2	0.00	2.24	0.95	0.16
250672	0	2	0.00	2.24	0.95	0.16
090772	0	2	0.00	2.24	0.95	0.16
230772	0	2	0.00	2.24	0.95	0.16
060872	0	2	0.00	2.24	0.95	0.16
300473	0	2	0.00	2.24	0.95	0.16
140573	0	2	0.00	2.24	0.95	0.16
280573	0	2	0.00	2.24	0.95	0.16
110673	0	2	0.00	2.24	0.95	0.16
250673	0	2	0.00	2.24	0.95	0.16
090773	0	2	0.00	2.24	0.95	0.16
230773	0	2	0.00	2.24	0.95	0.16
060873	0	2	0.00	2.24	0.95	0.16
300474	0	2	0.00	2.24	0.95	0.16
140574	0	2	0.00	2.24	0.95	0.16
280574	0	2	0.00	2.24	0.95	0.16
110674	0	2	0.00	2.24	0.95	0.16
250674	0	2	0.00	2.24	0.95	0.16
090774	0	2	0.00	2.24	0.95	0.16
230774	0	2	0.00	2.24	0.95	0.16
060874	0	2	0.00	2.24	0.95	0.16
300475	0	2	0.00	2.24	0.95	0.16
140575	0	2	0.00	2.24	0.95	0.16
280575	0	2	0.00	2.24	0.95	0.16
110675	0	2	0.00	2.24	0.95	0.16
250675	0	2	0.00	2.24	0.95	0.16
090775	0	2	0.00	2.24	0.95	0.16

230775	0	2	0.00	2.24	0.95	0.16
060875	0	2	0.00	2.24	0.95	0.16
300476	0	2	0.00	2.24	0.95	0.16
140576	0	2	0.00	2.24	0.95	0.16
280576	0	2	0.00	2.24	0.95	0.16
110676	0	2	0.00	2.24	0.95	0.16
250676	0	2	0.00	2.24	0.95	0.16
090776	0	2	0.00	2.24	0.95	0.16
230776	0	2	0.00	2.24	0.95	0.16
060876	0	2	0.00	2.24	0.95	0.16
300477	0	2	0.00	2.24	0.95	0.16
140577	0	2	0.00	2.24	0.95	0.16
280577	0	2	0.00	2.24	0.95	0.16
110677	0	2	0.00	2.24	0.95	0.16
250677	0	2	0.00	2.24	0.95	0.16
090777	0	2	0.00	2.24	0.95	0.16
230777	0	2	0.00	2.24	0.95	0.16
060877	0	2	0.00	2.24	0.95	0.16
300478	0	2	0.00	2.24	0.95	0.16
140578	0	2	0.00	2.24	0.95	0.16
280578	0	2	0.00	2.24	0.95	0.16
110678	0	2	0.00	2.24	0.95	0.16
250678	0	2	0.00	2.24	0.95	0.16
090778	0	2	0.00	2.24	0.95	0.16
230778	0	2	0.00	2.24	0.95	0.16
060878	0	2	0.00	2.24	0.95	0.16
300479	0	2	0.00	2.24	0.95	0.16
140579	0	2	0.00	2.24	0.95	0.16
280579	0	2	0.00	2.24	0.95	0.16
110679	0	2	0.00	2.24	0.95	0.16
250679	0	2	0.00	2.24	0.95	0.16
090779	0	2	0.00	2.24	0.95	0.16
230779	0	2	0.00	2.24	0.95	0.16
060879	0	2	0.00	2.24	0.95	0.16
300480	0	2	0.00	2.24	0.95	0.16
140580	0	2	0.00	2.24	0.95	0.16
280580	0	2	0.00	2.24	0.95	0.16
110680	0	2	0.00	2.24	0.95	0.16
250680	0	2	0.00	2.24	0.95	0.16
090780	0	2	0.00	2.24	0.95	0.16
230780	0	2	0.00	2.24	0.95	0.16
060880	0	2	0.00	2.24	0.95	0.16
300481	0	2	0.00	2.24	0.95	0.16
140581	0	2	0.00	2.24	0.95	0.16
280581	0	2	0.00	2.24	0.95	0.16
110681	0	2	0.00	2.24	0.95	0.16
250681	0	2	0.00	2.24	0.95	0.16
090781	0	2	0.00	2.24	0.95	0.16
230781	0	2	0.00	2.24	0.95	0.16
060881	0	2	0.00	2.24	0.95	0.16
300482	0	2	0.00	2.24	0.95	0.16
140582	0	2	0.00	2.24	0.95	0.16
280582	0	2	0.00	2.24	0.95	0.16
110682	0	2	0.00	2.24	0.95	0.16
250682	0	2	0.00	2.24	0.95	0.16
090782	0	2	0.00	2.24	0.95	0.16
230782	0	2	0.00	2.24	0.95	0.16
060882	0	2	0.00	2.24	0.95	0.16
300483	0	2	0.00	2.24	0.95	0.16
140583	0	2	0.00	2.24	0.95	0.16
280583	0	2	0.00	2.24	0.95	0.16

```
  110683  0 2 0.00  2.24 0.95 0.16
  250683  0 2 0.00  2.24 0.95 0.16
  090783  0 2 0.00  2.24 0.95 0.16
  230783  0 2 0.00  2.24 0.95 0.16
  060883  0 2 0.00  2.24 0.95 0.16

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
       0
            YEAR      10            YEAR      10            YEAR      10   1
       1
       1  -----
       7    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

Average Application Rate Ohio Sweet Corn, Index Reservoir

```
*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted 3/30/2000
***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00
*** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE VALUES on
2/28/01 ***
*** Manning's N values for cornstalk residue, fallow surface, 1 ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami; brookston;
glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063; Ground spray:
0.064 ***
*** Application efficiency: 0.95 aerial; 0.99 spray blast and ground spray ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50   172.8    5.80       3    6.00   600.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00  100.00
*** - RECORD 9A ***
       1       3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
  160558  260958  111058       1
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
```

```
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Application by ground spray Rate = "average" from QUA memo (July 21, 1998) - 3
apps @ 1.1 lb a.i./acre
***Application: X Application Method.  2 apps @ 8 lb a.i./acre (8.9
kgs/hectare
*** - RECORD 13 ***
     108       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days; AnSM T1/2 = 24
days
*** - RECORD 16 ***
  300448  0 2 0.00  1.23 0.95 0.064
  140548  0 2 0.00  1.23 0.95 0.064
  280548  0 2 0.00  1.23 0.95 0.064
  300449  0 2 0.00  1.23 0.95 0.064
  140549  0 2 0.00  1.23 0.95 0.064
  280549  0 2 0.00  1.23 0.95 0.064
  300450  0 2 0.00  1.23 0.95 0.064
  140550  0 2 0.00  1.23 0.95 0.064
  280550  0 2 0.00  1.23 0.95 0.064
  300451  0 2 0.00  1.23 0.95 0.064
  140551  0 2 0.00  1.23 0.95 0.064
  280551  0 2 0.00  1.23 0.95 0.064
  300452  0 2 0.00  1.23 0.95 0.064
  140552  0 2 0.00  1.23 0.95 0.064
  280552  0 2 0.00  1.23 0.95 0.064
  300453  0 2 0.00  1.23 0.95 0.064
  140553  0 2 0.00  1.23 0.95 0.064
  280553  0 2 0.00  1.23 0.95 0.064
  300454  0 2 0.00  1.23 0.95 0.064
  140554  0 2 0.00  1.23 0.95 0.064
  280554  0 2 0.00  1.23 0.95 0.064
  300455  0 2 0.00  1.23 0.95 0.064
  140555  0 2 0.00  1.23 0.95 0.064
  280555  0 2 0.00  1.23 0.95 0.064
  300456  0 2 0.00  1.23 0.95 0.064
  140556  0 2 0.00  1.23 0.95 0.064
  280556  0 2 0.00  1.23 0.95 0.064
  300457  0 2 0.00  1.23 0.95 0.064
  140557  0 2 0.00  1.23 0.95 0.064
  280557  0 2 0.00  1.23 0.95 0.064
  300458  0 2 0.00  1.23 0.95 0.064
  140558  0 2 0.00  1.23 0.95 0.064
  280558  0 2 0.00  1.23 0.95 0.064
  300459  0 2 0.00  1.23 0.95 0.064
  140559  0 2 0.00  1.23 0.95 0.064
  280559  0 2 0.00  1.23 0.95 0.064
```

300460	0	2	0.00	1.23	0.95	0.064
140560	0	2	0.00	1.23	0.95	0.064
280560	0	2	0.00	1.23	0.95	0.064
300461	0	2	0.00	1.23	0.95	0.064
140561	0	2	0.00	1.23	0.95	0.064
280561	0	2	0.00	1.23	0.95	0.064
300462	0	2	0.00	1.23	0.95	0.064
140562	0	2	0.00	1.23	0.95	0.064
280562	0	2	0.00	1.23	0.95	0.064
300463	0	2	0.00	1.23	0.95	0.064
140563	0	2	0.00	1.23	0.95	0.064
280563	0	2	0.00	1.23	0.95	0.064
300464	0	2	0.00	1.23	0.95	0.064
140564	0	2	0.00	1.23	0.95	0.064
280564	0	2	0.00	1.23	0.95	0.064
300465	0	2	0.00	1.23	0.95	0.064
140565	0	2	0.00	1.23	0.95	0.064
280565	0	2	0.00	1.23	0.95	0.064
300466	0	2	0.00	1.23	0.95	0.064
140566	0	2	0.00	1.23	0.95	0.064
280566	0	2	0.00	1.23	0.95	0.064
300467	0	2	0.00	1.23	0.95	0.064
140567	0	2	0.00	1.23	0.95	0.064
280567	0	2	0.00	1.23	0.95	0.064
300468	0	2	0.00	1.23	0.95	0.064
140568	0	2	0.00	1.23	0.95	0.064
280568	0	2	0.00	1.23	0.95	0.064
300469	0	2	0.00	1.23	0.95	0.064
140569	0	2	0.00	1.23	0.95	0.064
280569	0	2	0.00	1.23	0.95	0.064
300470	0	2	0.00	1.23	0.95	0.064
140570	0	2	0.00	1.23	0.95	0.064
280570	0	2	0.00	1.23	0.95	0.064
300471	0	2	0.00	1.23	0.95	0.064
140571	0	2	0.00	1.23	0.95	0.064
280571	0	2	0.00	1.23	0.95	0.064
300472	0	2	0.00	1.23	0.95	0.064
140572	0	2	0.00	1.23	0.95	0.064
280572	0	2	0.00	1.23	0.95	0.064
300473	0	2	0.00	1.23	0.95	0.064
140573	0	2	0.00	1.23	0.95	0.064
280573	0	2	0.00	1.23	0.95	0.064
300474	0	2	0.00	1.23	0.95	0.064
140574	0	2	0.00	1.23	0.95	0.064
280574	0	2	0.00	1.23	0.95	0.064
300475	0	2	0.00	1.23	0.95	0.064
140575	0	2	0.00	1.23	0.95	0.064
280575	0	2	0.00	1.23	0.95	0.064
300476	0	2	0.00	1.23	0.95	0.064
140576	0	2	0.00	1.23	0.95	0.064
280576	0	2	0.00	1.23	0.95	0.064
300477	0	2	0.00	1.23	0.95	0.064
140577	0	2	0.00	1.23	0.95	0.064
280577	0	2	0.00	1.23	0.95	0.064
300478	0	2	0.00	1.23	0.95	0.064
140578	0	2	0.00	1.23	0.95	0.064
280578	0	2	0.00	1.23	0.95	0.064
300479	0	2	0.00	1.23	0.95	0.064
140579	0	2	0.00	1.23	0.95	0.064
280579	0	2	0.00	1.23	0.95	0.064
300480	0	2	0.00	1.23	0.95	0.064

```
  140580  0 2 0.00  1.23 0.95 0.064
  280580  0 2 0.00  1.23 0.95 0.064
  300481  0 2 0.00  1.23 0.95 0.064
  140581  0 2 0.00  1.23 0.95 0.064
  280581  0 2 0.00  1.23 0.95 0.064
  300482  0 2 0.00  1.23 0.95 0.064
  140582  0 2 0.00  1.23 0.95 0.064
  280582  0 2 0.00  1.23 0.95 0.064
  300483  0 2 0.00  1.23 0.95 0.064
  140583  0 2 0.00  1.23 0.95 0.064
  280583  0 2 0.00  1.23 0.95 0.064
*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
       0
            YEAR      10            YEAR      10            YEAR      10   1
       1
       1  -----
       7    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

Maximum Reported Application Rate Ohio Sweet Corn, Index Reservoir

```
*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted
3/30/2000 ***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00
*** Manning's N values for cornstalk residue, fallow surface, 1
ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami;
brookston; glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063;
Ground spray: 0.064 ***
*** Application efficiency: 0.95 aerial; 0.99 spray blast and
ground spray ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50   172.8    5.80       3    6.00   600.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00
100.00
*** - RECORD 9A ***
       1      3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
  160558  260958  111058       1
  160559  260959  111059       1
```

```
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Max reported application - 3 apps @ 1 lb A.I./acre
*** Application: aerial Application Method.  2 apps @ 8 lb
a.i./acre (8.9 kgs/hectare
*** - RECORD 13 ***
     108       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days;
AnSM T1/2 = 24 days
*** - RECORD 16 ***
  300448  0 2 0.00  1.12 0.95 0.16
  140548  0 2 0.00  1.12 0.95 0.16
  280548  0 2 0.00  1.12 0.95 0.16
  300449  0 2 0.00  1.12 0.95 0.16
  140549  0 2 0.00  1.12 0.95 0.16
  280549  0 2 0.00  1.12 0.95 0.16
  300450  0 2 0.00  1.12 0.95 0.16
  140550  0 2 0.00  1.12 0.95 0.16
  280550  0 2 0.00  1.12 0.95 0.16
  300451  0 2 0.00  1.12 0.95 0.16
  140551  0 2 0.00  1.12 0.95 0.16
  280551  0 2 0.00  1.12 0.95 0.16
  300452  0 2 0.00  1.12 0.95 0.16
  140552  0 2 0.00  1.12 0.95 0.16
  280552  0 2 0.00  1.12 0.95 0.16
  300453  0 2 0.00  1.12 0.95 0.16
  140553  0 2 0.00  1.12 0.95 0.16
  280553  0 2 0.00  1.12 0.95 0.16
```

300454	0	2	0.00	1.12	0.95	0.16
140554	0	2	0.00	1.12	0.95	0.16
280554	0	2	0.00	1.12	0.95	0.16
300455	0	2	0.00	1.12	0.95	0.16
140555	0	2	0.00	1.12	0.95	0.16
280555	0	2	0.00	1.12	0.95	0.16
300456	0	2	0.00	1.12	0.95	0.16
140556	0	2	0.00	1.12	0.95	0.16
280556	0	2	0.00	1.12	0.95	0.16
300457	0	2	0.00	1.12	0.95	0.16
140557	0	2	0.00	1.12	0.95	0.16
280557	0	2	0.00	1.12	0.95	0.16
300458	0	2	0.00	1.12	0.95	0.16
140558	0	2	0.00	1.12	0.95	0.16
280558	0	2	0.00	1.12	0.95	0.16
300459	0	2	0.00	1.12	0.95	0.16
140559	0	2	0.00	1.12	0.95	0.16
280559	0	2	0.00	1.12	0.95	0.16
300460	0	2	0.00	1.12	0.95	0.16
140560	0	2	0.00	1.12	0.95	0.16
280560	0	2	0.00	1.12	0.95	0.16
300461	0	2	0.00	1.12	0.95	0.16
140561	0	2	0.00	1.12	0.95	0.16
280561	0	2	0.00	1.12	0.95	0.16
300462	0	2	0.00	1.12	0.95	0.16
140562	0	2	0.00	1.12	0.95	0.16
280562	0	2	0.00	1.12	0.95	0.16
300463	0	2	0.00	1.12	0.95	0.16
140563	0	2	0.00	1.12	0.95	0.16
280563	0	2	0.00	1.12	0.95	0.16
300464	0	2	0.00	1.12	0.95	0.16
140564	0	2	0.00	1.12	0.95	0.16
280564	0	2	0.00	1.12	0.95	0.16
300465	0	2	0.00	1.12	0.95	0.16
140565	0	2	0.00	1.12	0.95	0.16
280565	0	2	0.00	1.12	0.95	0.16
300466	0	2	0.00	1.12	0.95	0.16
140566	0	2	0.00	1.12	0.95	0.16
280566	0	2	0.00	1.12	0.95	0.16
300467	0	2	0.00	1.12	0.95	0.16
140567	0	2	0.00	1.12	0.95	0.16
280567	0	2	0.00	1.12	0.95	0.16
300468	0	2	0.00	1.12	0.95	0.16
140568	0	2	0.00	1.12	0.95	0.16
280568	0	2	0.00	1.12	0.95	0.16
300469	0	2	0.00	1.12	0.95	0.16
140569	0	2	0.00	1.12	0.95	0.16
280569	0	2	0.00	1.12	0.95	0.16
300470	0	2	0.00	1.12	0.95	0.16
140570	0	2	0.00	1.12	0.95	0.16
280570	0	2	0.00	1.12	0.95	0.16
300471	0	2	0.00	1.12	0.95	0.16

```
  140571  0 2 0.00  1.12 0.95 0.16
  280571  0 2 0.00  1.12 0.95 0.16
  300472  0 2 0.00  1.12 0.95 0.16
  140572  0 2 0.00  1.12 0.95 0.16
  280572  0 2 0.00  1.12 0.95 0.16
  300473  0 2 0.00  1.12 0.95 0.16
  140573  0 2 0.00  1.12 0.95 0.16
  280573  0 2 0.00  1.12 0.95 0.16
  300474  0 2 0.00  1.12 0.95 0.16
  140574  0 2 0.00  1.12 0.95 0.16
  280574  0 2 0.00  1.12 0.95 0.16
  300475  0 2 0.00  1.12 0.95 0.16
  140575  0 2 0.00  1.12 0.95 0.16
  280575  0 2 0.00  1.12 0.95 0.16
  300476  0 2 0.00  1.12 0.95 0.16
  140576  0 2 0.00  1.12 0.95 0.16
  280576  0 2 0.00  1.12 0.95 0.16
  300477  0 2 0.00  1.12 0.95 0.16
  140577  0 2 0.00  1.12 0.95 0.16
  280577  0 2 0.00  1.12 0.95 0.16
  300478  0 2 0.00  1.12 0.95 0.16
  140578  0 2 0.00  1.12 0.95 0.16
  280578  0 2 0.00  1.12 0.95 0.16
  300479  0 2 0.00  1.12 0.95 0.16
  140579  0 2 0.00  1.12 0.95 0.16
  280579  0 2 0.00  1.12 0.95 0.16
  300480  0 2 0.00  1.12 0.95 0.16
  140580  0 2 0.00  1.12 0.95 0.16
  280580  0 2 0.00  1.12 0.95 0.16
  300481  0 2 0.00  1.12 0.95 0.16
  140581  0 2 0.00  1.12 0.95 0.16
  280581  0 2 0.00  1.12 0.95 0.16
  300482  0 2 0.00  1.12 0.95 0.16
  140582  0 2 0.00  1.12 0.95 0.16
  280582  0 2 0.00  1.12 0.95 0.16
  300483  0 2 0.00  1.12 0.95 0.16
  140583  0 2 0.00  1.12 0.95 0.16
  280583  0 2 0.00  1.12 0.95 0.16

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
```

```
    1  22.000   1.600   0.294   0.000   0.000   0.000
       0.058  0.058   0.000
        0.200   0.294   0.086   1.160    3.0
    2  78.000   1.650   0.147   0.000   0.000   0.000
       0.029  0.029   0.000
        1.000   0.147   0.087   0.174    3.0
    0
         YEAR      10             YEAR      10             YEAR
10   1
    1
    1  -----
    7    YEAR
 PRCP    TSER   0   0
 RUNF    TSER   0   0
 INFL    TSER   1   1
 ESLS    TSER   0   0   1.E3
 RFLX    TSER   0   0   1.E5
 EFLX    TSER   0   0   1.E5
 RZFX    TSER   0   0   1.E5
```

Maximum Application Rate Ohio Corn, Index Reservoir

```
*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted
3/30/2000 ***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00
*** Manning's N values for cornstalk residue, fallow surface, 1
ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami;
brookston; glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063;
Ground spray: 0.064 ***
*** Application efficiency: 0.95 aerial; 0.99 spray blast and
ground spray ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50   172.8    5.80       3    6.00   600.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00
100.00
*** - RECORD 9A ***
       1       3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
  160558  260958  111058       1
```

```
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Application: X Application Method.  4 apps @ 2 lb a.i./acre
*** - RECORD 13 ***
     144       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days;
AnSM T1/2 = 24 days
*** - RECORD 16 ***
  300448  0 2 0.00  2.24 0.95 0.16
  140548  0 2 0.00  2.24 0.95 0.16
  280548  0 2 0.00  2.24 0.95 0.16
  110648  0 2 0.00  2.24 0.95 0.16
  300449  0 2 0.00  2.24 0.95 0.16
  140549  0 2 0.00  2.24 0.95 0.16
  280549  0 2 0.00  2.24 0.95 0.16
  110649  0 2 0.00  2.24 0.95 0.16
  300450  0 2 0.00  2.24 0.95 0.16
  140550  0 2 0.00  2.24 0.95 0.16
  280550  0 2 0.00  2.24 0.95 0.16
  110650  0 2 0.00  2.24 0.95 0.16
  300451  0 2 0.00  2.24 0.95 0.16
  140551  0 2 0.00  2.24 0.95 0.16
  280551  0 2 0.00  2.24 0.95 0.16
  110651  0 2 0.00  2.24 0.95 0.16
  300452  0 2 0.00  2.24 0.95 0.16
```

140552	0	2	0.00	2.24	0.95	0.16
280552	0	2	0.00	2.24	0.95	0.16
110652	0	2	0.00	2.24	0.95	0.16
300453	0	2	0.00	2.24	0.95	0.16
140553	0	2	0.00	2.24	0.95	0.16
280553	0	2	0.00	2.24	0.95	0.16
110653	0	2	0.00	2.24	0.95	0.16
300454	0	2	0.00	2.24	0.95	0.16
140554	0	2	0.00	2.24	0.95	0.16
280554	0	2	0.00	2.24	0.95	0.16
110654	0	2	0.00	2.24	0.95	0.16
300455	0	2	0.00	2.24	0.95	0.16
140555	0	2	0.00	2.24	0.95	0.16
280555	0	2	0.00	2.24	0.95	0.16
110655	0	2	0.00	2.24	0.95	0.16
300456	0	2	0.00	2.24	0.95	0.16
140556	0	2	0.00	2.24	0.95	0.16
280556	0	2	0.00	2.24	0.95	0.16
110656	0	2	0.00	2.24	0.95	0.16
300457	0	2	0.00	2.24	0.95	0.16
140557	0	2	0.00	2.24	0.95	0.16
280557	0	2	0.00	2.24	0.95	0.16
110657	0	2	0.00	2.24	0.95	0.16
300458	0	2	0.00	2.24	0.95	0.16
140558	0	2	0.00	2.24	0.95	0.16
280558	0	2	0.00	2.24	0.95	0.16
110658	0	2	0.00	2.24	0.95	0.16
300459	0	2	0.00	2.24	0.95	0.16
140559	0	2	0.00	2.24	0.95	0.16
280559	0	2	0.00	2.24	0.95	0.16
110659	0	2	0.00	2.24	0.95	0.16
300460	0	2	0.00	2.24	0.95	0.16
140560	0	2	0.00	2.24	0.95	0.16
280560	0	2	0.00	2.24	0.95	0.16
110660	0	2	0.00	2.24	0.95	0.16
300461	0	2	0.00	2.24	0.95	0.16
140561	0	2	0.00	2.24	0.95	0.16
280561	0	2	0.00	2.24	0.95	0.16
110661	0	2	0.00	2.24	0.95	0.16
300462	0	2	0.00	2.24	0.95	0.16
140562	0	2	0.00	2.24	0.95	0.16
280562	0	2	0.00	2.24	0.95	0.16
110662	0	2	0.00	2.24	0.95	0.16
300463	0	2	0.00	2.24	0.95	0.16
140563	0	2	0.00	2.24	0.95	0.16
280563	0	2	0.00	2.24	0.95	0.16
110663	0	2	0.00	2.24	0.95	0.16
300464	0	2	0.00	2.24	0.95	0.16
140564	0	2	0.00	2.24	0.95	0.16
280564	0	2	0.00	2.24	0.95	0.16

110664	0	2	0.00	2.24	0.95	0.16
300465	0	2	0.00	2.24	0.95	0.16
140565	0	2	0.00	2.24	0.95	0.16
280565	0	2	0.00	2.24	0.95	0.16
110665	0	2	0.00	2.24	0.95	0.16
300466	0	2	0.00	2.24	0.95	0.16
140566	0	2	0.00	2.24	0.95	0.16
280566	0	2	0.00	2.24	0.95	0.16
110666	0	2	0.00	2.24	0.95	0.16
300467	0	2	0.00	2.24	0.95	0.16
140567	0	2	0.00	2.24	0.95	0.16
280567	0	2	0.00	2.24	0.95	0.16
110667	0	2	0.00	2.24	0.95	0.16
300468	0	2	0.00	2.24	0.95	0.16
140568	0	2	0.00	2.24	0.95	0.16
280568	0	2	0.00	2.24	0.95	0.16
110668	0	2	0.00	2.24	0.95	0.16
300469	0	2	0.00	2.24	0.95	0.16
140569	0	2	0.00	2.24	0.95	0.16
280569	0	2	0.00	2.24	0.95	0.16
110669	0	2	0.00	2.24	0.95	0.16
300470	0	2	0.00	2.24	0.95	0.16
140570	0	2	0.00	2.24	0.95	0.16
280570	0	2	0.00	2.24	0.95	0.16
110670	0	2	0.00	2.24	0.95	0.16
300471	0	2	0.00	2.24	0.95	0.16
140571	0	2	0.00	2.24	0.95	0.16
280571	0	2	0.00	2.24	0.95	0.16
110671	0	2	0.00	2.24	0.95	0.16
300472	0	2	0.00	2.24	0.95	0.16
140572	0	2	0.00	2.24	0.95	0.16
280572	0	2	0.00	2.24	0.95	0.16
110672	0	2	0.00	2.24	0.95	0.16
300473	0	2	0.00	2.24	0.95	0.16
140573	0	2	0.00	2.24	0.95	0.16
280573	0	2	0.00	2.24	0.95	0.16
110673	0	2	0.00	2.24	0.95	0.16
300474	0	2	0.00	2.24	0.95	0.16
140574	0	2	0.00	2.24	0.95	0.16
280574	0	2	0.00	2.24	0.95	0.16
110674	0	2	0.00	2.24	0.95	0.16
300475	0	2	0.00	2.24	0.95	0.16
140575	0	2	0.00	2.24	0.95	0.16
280575	0	2	0.00	2.24	0.95	0.16
110675	0	2	0.00	2.24	0.95	0.16
300476	0	2	0.00	2.24	0.95	0.16
140576	0	2	0.00	2.24	0.95	0.16
280576	0	2	0.00	2.24	0.95	0.16
110676	0	2	0.00	2.24	0.95	0.16
300477	0	2	0.00	2.24	0.95	0.16

```
  140577  0 2 0.00  2.24 0.95 0.16
  280577  0 2 0.00  2.24 0.95 0.16
  110677  0 2 0.00  2.24 0.95 0.16
  300478  0 2 0.00  2.24 0.95 0.16
  140578  0 2 0.00  2.24 0.95 0.16
  280578  0 2 0.00  2.24 0.95 0.16
  110678  0 2 0.00  2.24 0.95 0.16
  300479  0 2 0.00  2.24 0.95 0.16
  140579  0 2 0.00  2.24 0.95 0.16
  280579  0 2 0.00  2.24 0.95 0.16
  110679  0 2 0.00  2.24 0.95 0.16
  300480  0 2 0.00  2.24 0.95 0.16
  140580  0 2 0.00  2.24 0.95 0.16
  280580  0 2 0.00  2.24 0.95 0.16
  110680  0 2 0.00  2.24 0.95 0.16
  300481  0 2 0.00  2.24 0.95 0.16
  140581  0 2 0.00  2.24 0.95 0.16
  280581  0 2 0.00  2.24 0.95 0.16
  110681  0 2 0.00  2.24 0.95 0.16
  300482  0 2 0.00  2.24 0.95 0.16
  140582  0 2 0.00  2.24 0.95 0.16
  280582  0 2 0.00  2.24 0.95 0.16
  110682  0 2 0.00  2.24 0.95 0.16
  300483  0 2 0.00  2.24 0.95 0.16
  140583  0 2 0.00  2.24 0.95 0.16
  280583  0 2 0.00  2.24 0.95 0.16
  110683  0 2 0.00  2.24 0.95 0.16

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
       0
            YEAR      10            YEAR      10            YEAR
   10   1
```

```
   1
   1  -----
   7    YEAR
PRCP    TSER   0   0
RUNF    TSER   0   0
INFL    TSER   1   1
ESLS    TSER   0   0   1.E3
RFLX    TSER   0   0   1.E5
EFLX    TSER   0   0   1.E5
RZFX    TSER   0   0   1.E5
```

Average Reported Application Rate Ohio Corn, Index Reservoir

```
*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted
3/30/2000 ***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00
*** Manning's N values for cornstalk residue, fallow surface, 1
ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami;
brookston; glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063;
Ground spray: 0.064 ***
*** Application efficiency: 0.95 aerial; 0.99 spray blast and
ground spray ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50   172.8    5.80       3    6.00   600.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00
100.00
*** - RECORD 9A ***
       1      3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
```

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  160557  260957  111057       1
  160558  260958  111058       1
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Average app rate - 2 apps @ 1 lb A.I./acre
*** Application: aerial Application at max label rate 4 apps @ 2
lb a.i./acre
*** - RECORD 13 ***
      72       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days;
AnSM T1/2 = 24 days
*** - RECORD 16 ***
  300448  0 2 0.00  1.12 0.95 0.16
  140548  0 2 0.00  1.12 0.95 0.16
  300449  0 2 0.00  1.12 0.95 0.16
  140549  0 2 0.00  1.12 0.95 0.16
  300450  0 2 0.00  1.12 0.95 0.16
  140550  0 2 0.00  1.12 0.95 0.16
  300451  0 2 0.00  1.12 0.95 0.16
  140551  0 2 0.00  1.12 0.95 0.16
  300452  0 2 0.00  1.12 0.95 0.16
  140552  0 2 0.00  1.12 0.95 0.16
  300453  0 2 0.00  1.12 0.95 0.16
  140553  0 2 0.00  1.12 0.95 0.16
  300454  0 2 0.00  1.12 0.95 0.16
```

140554	0	2	0.00	1.12	0.95	0.16
300455	0	2	0.00	1.12	0.95	0.16
140555	0	2	0.00	1.12	0.95	0.16
300456	0	2	0.00	1.12	0.95	0.16
140556	0	2	0.00	1.12	0.95	0.16
300457	0	2	0.00	1.12	0.95	0.16
140557	0	2	0.00	1.12	0.95	0.16
300458	0	2	0.00	1.12	0.95	0.16
140558	0	2	0.00	1.12	0.95	0.16
300459	0	2	0.00	1.12	0.95	0.16
140559	0	2	0.00	1.12	0.95	0.16
300460	0	2	0.00	1.12	0.95	0.16
140560	0	2	0.00	1.12	0.95	0.16
300461	0	2	0.00	1.12	0.95	0.16
140561	0	2	0.00	1.12	0.95	0.16
300462	0	2	0.00	1.12	0.95	0.16
140562	0	2	0.00	1.12	0.95	0.16
300463	0	2	0.00	1.12	0.95	0.16
140563	0	2	0.00	1.12	0.95	0.16
300464	0	2	0.00	1.12	0.95	0.16
140564	0	2	0.00	1.12	0.95	0.16
300465	0	2	0.00	1.12	0.95	0.16
140565	0	2	0.00	1.12	0.95	0.16
300466	0	2	0.00	1.12	0.95	0.16
140566	0	2	0.00	1.12	0.95	0.16
300467	0	2	0.00	1.12	0.95	0.16
140567	0	2	0.00	1.12	0.95	0.16
300468	0	2	0.00	1.12	0.95	0.16
140568	0	2	0.00	1.12	0.95	0.16
300469	0	2	0.00	1.12	0.95	0.16
140569	0	2	0.00	1.12	0.95	0.16
300470	0	2	0.00	1.12	0.95	0.16
140570	0	2	0.00	1.12	0.95	0.16
300471	0	2	0.00	1.12	0.95	0.16
140571	0	2	0.00	1.12	0.95	0.16
300472	0	2	0.00	1.12	0.95	0.16
140572	0	2	0.00	1.12	0.95	0.16
300473	0	2	0.00	1.12	0.95	0.16
140573	0	2	0.00	1.12	0.95	0.16
300474	0	2	0.00	1.12	0.95	0.16
140574	0	2	0.00	1.12	0.95	0.16
300475	0	2	0.00	1.12	0.95	0.16
140575	0	2	0.00	1.12	0.95	0.16
300476	0	2	0.00	1.12	0.95	0.16
140576	0	2	0.00	1.12	0.95	0.16
300477	0	2	0.00	1.12	0.95	0.16
140577	0	2	0.00	1.12	0.95	0.16
300478	0	2	0.00	1.12	0.95	0.16
140578	0	2	0.00	1.12	0.95	0.16
300479	0	2	0.00	1.12	0.95	0.16

```
  140579  0 2 0.00  1.12 0.95 0.16
  300480  0 2 0.00  1.12 0.95 0.16
  140580  0 2 0.00  1.12 0.95 0.16
  300481  0 2 0.00  1.12 0.95 0.16
  140581  0 2 0.00  1.12 0.95 0.16
  300482  0 2 0.00  1.12 0.95 0.16
  140582  0 2 0.00  1.12 0.95 0.16
  300483  0 2 0.00  1.12 0.95 0.16
  140583  0 2 0.00  1.12 0.95 0.16

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
       0
            YEAR      10             YEAR      10             YEAR
   10   1
       1
       1  -----
       7    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

Maximum Reported Application Rate Ohio Corn, Index Reservoir

```
*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted
3/30/2000 ***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00
*** Manning's N values for cornstalk residue, fallow surface, 1
ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami;
brookston; glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063;
Ground spray: 0.064 ***
*** Application efficiency: 0.95 aerial; 0.99 spray blast and
ground spray ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50   172.8    5.80       3    6.00   600.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00
100.00
*** - RECORD 9A ***
       1      3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
```

```
  160558  260958  111058       1
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Max reported app rate - 2 apps @ 1.5 lb A.I./acre
*** Application: aerial Application at max label rate 4 apps @ 2
lb a.i./acre
*** - RECORD 13 ***
      72       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days;
AnSM T1/2 = 24 days
*** - RECORD 16 ***
  300448  0 2 0.00  1.68 0.95 0.16
  140548  0 2 0.00  1.68 0.95 0.16
  300449  0 2 0.00  1.68 0.95 0.16
  140549  0 2 0.00  1.68 0.95 0.16
  300450  0 2 0.00  1.68 0.95 0.16
  140550  0 2 0.00  1.68 0.95 0.16
  300451  0 2 0.00  1.68 0.95 0.16
  140551  0 2 0.00  1.68 0.95 0.16
  300452  0 2 0.00  1.68 0.95 0.16
  140552  0 2 0.00  1.68 0.95 0.16
  300453  0 2 0.00  1.68 0.95 0.16
  140553  0 2 0.00  1.68 0.95 0.16
  300454  0 2 0.00  1.68 0.95 0.16
  140554  0 2 0.00  1.68 0.95 0.16
```

300455	0	2	0.00	1.68	0.95	0.16
140555	0	2	0.00	1.68	0.95	0.16
300456	0	2	0.00	1.68	0.95	0.16
140556	0	2	0.00	1.68	0.95	0.16
300457	0	2	0.00	1.68	0.95	0.16
140557	0	2	0.00	1.68	0.95	0.16
300458	0	2	0.00	1.68	0.95	0.16
140558	0	2	0.00	1.68	0.95	0.16
300459	0	2	0.00	1.68	0.95	0.16
140559	0	2	0.00	1.68	0.95	0.16
300460	0	2	0.00	1.68	0.95	0.16
140560	0	2	0.00	1.68	0.95	0.16
300461	0	2	0.00	1.68	0.95	0.16
140561	0	2	0.00	1.68	0.95	0.16
300462	0	2	0.00	1.68	0.95	0.16
140562	0	2	0.00	1.68	0.95	0.16
300463	0	2	0.00	1.68	0.95	0.16
140563	0	2	0.00	1.68	0.95	0.16
300464	0	2	0.00	1.68	0.95	0.16
140564	0	2	0.00	1.68	0.95	0.16
300465	0	2	0.00	1.68	0.95	0.16
140565	0	2	0.00	1.68	0.95	0.16
300466	0	2	0.00	1.68	0.95	0.16
140566	0	2	0.00	1.68	0.95	0.16
300467	0	2	0.00	1.68	0.95	0.16
140567	0	2	0.00	1.68	0.95	0.16
300468	0	2	0.00	1.68	0.95	0.16
140568	0	2	0.00	1.68	0.95	0.16
300469	0	2	0.00	1.68	0.95	0.16
140569	0	2	0.00	1.68	0.95	0.16
300470	0	2	0.00	1.68	0.95	0.16
140570	0	2	0.00	1.68	0.95	0.16
300471	0	2	0.00	1.68	0.95	0.16
140571	0	2	0.00	1.68	0.95	0.16
300472	0	2	0.00	1.68	0.95	0.16
140572	0	2	0.00	1.68	0.95	0.16
300473	0	2	0.00	1.68	0.95	0.16
140573	0	2	0.00	1.68	0.95	0.16
300474	0	2	0.00	1.68	0.95	0.16
140574	0	2	0.00	1.68	0.95	0.16
300475	0	2	0.00	1.68	0.95	0.16
140575	0	2	0.00	1.68	0.95	0.16
300476	0	2	0.00	1.68	0.95	0.16
140576	0	2	0.00	1.68	0.95	0.16
300477	0	2	0.00	1.68	0.95	0.16
140577	0	2	0.00	1.68	0.95	0.16
300478	0	2	0.00	1.68	0.95	0.16
140578	0	2	0.00	1.68	0.95	0.16
300479	0	2	0.00	1.68	0.95	0.16
140579	0	2	0.00	1.68	0.95	0.16

```
  300480  0 2 0.00  1.68 0.95 0.16
  140580  0 2 0.00  1.68 0.95 0.16
  300481  0 2 0.00  1.68 0.95 0.16
  140581  0 2 0.00  1.68 0.95 0.16
  300482  0 2 0.00  1.68 0.95 0.16
  140582  0 2 0.00  1.68 0.95 0.16
  300483  0 2 0.00  1.68 0.95 0.16
  140583  0 2 0.00  1.68 0.95 0.16

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
       0
            YEAR      10            YEAR      10             YEAR
   10   1
       1
       1  -----
       7    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

Maximum Application Rate: Oregon Apples, Index Reservoir

```
*** PRZM 3.1 Input Data File; ORAPPLEX.INP; Modified April 5,
1998 ***
*** Modified for Carbaryl by Laurence Libelo, 6/21/00
*** Modified for Index Res. by Laurence Libelo, 3/7/01
*** Crops simulated: Apples, Crabapples, and Quince ***
*** Location Washington County, Oregon; Meadow/Orchard Scenario;
MLRA: A2 ***
*** Manning's N: Assume sparse grass under mature trees (ca. 20
feet) ***
*** Temperature data read ***
*** This file is for scenario standardization; Reference chemical
is Atrazine ***
*** See ORAPPLEX.wpd for scenario details ***
Carbaryl
Cornelius silt loam, 15% slope, Hydrologic Group: C
   0.740   0.150       2  17.000       1       3
     9.2    10.3    11.8    13.6    15.30   15.3
    14.2    12.5    10.9     9.4     8.6     9.1
       4
    0.43    3.30     1.0   172.8     5.4       2   15.00   464
       1
       1    0.25    17.0 100.000       3  91  71  71
  0.0     600
       1       3
0103  0105  0112
0.01  0.01  0.01
0.015 0.015 0.015
      36
  010448  150548  151248       1
  010449  150549  151249       1
  010450  150550  151250       1
  010451  150551  151251       1
  010452  150552  151252       1
  010453  150553  151253       1
  010454  150554  151254       1
  010455  150555  151255       1
  010456  150556  151256       1
  010457  150557  151257       1
  010458  150558  151258       1
  010459  150559  151259       1
  010460  150560  151260       1
  010461  150561  151261       1
  010462  150562  151262       1
  010463  150563  151263       1
  010464  150564  151264       1
  010465  150565  151265       1
  010466  150566  151266       1
  010467  150567  151267       1
```

```
  010468  150568  151268       1
  010469  150569  151269       1
  010470  150570  151270       1
  010471  150571  151271       1
  010472  150572  151272       1
  010473  150573  151273       1
  010474  150574  151274       1
  010475  150575  151275       1
  010476  150576  151276       1
  010477  150577  151277       1
  010478  150578  151278       1
  010479  150579  151279       1
  010480  150580  151280       1
  010481  150581  151281       1
  010482  150582  151282       1
  010483  150583  151283       1
Aerial Application: 5 apps of 2 lb a.i./acre (2.2 kg/ha), Aerial
@ 95% eff. w/16% drift
     180       1       0       0
Chemical Kd: 3.0 (silt Loam soil); AeSM: T1/2: 12 days; AnSM:
T1/2 = 24 days
*** Record 16: Application information; set specific to carbaryl
***
  100348  0 2 0.00  2.24 0.95 0.16
  140348  0 2 0.00  2.24 0.95 0.16
  180348  0 2 0.00  2.24 0.95 0.16
  220348  0 2 0.00  2.24 0.95 0.16
  260348  0 2 0.00  2.24 0.95 0.16
  100349  0 2 0.00  2.24 0.95 0.16
  140349  0 2 0.00  2.24 0.95 0.16
  180349  0 2 0.00  2.24 0.95 0.16
  220349  0 2 0.00  2.24 0.95 0.16
  260349  0 2 0.00  2.24 0.95 0.16
  100350  0 2 0.00  2.24 0.95 0.16
  140350  0 2 0.00  2.24 0.95 0.16
  180350  0 2 0.00  2.24 0.95 0.16
  220350  0 2 0.00  2.24 0.95 0.16
  260350  0 2 0.00  2.24 0.95 0.16
  100351  0 2 0.00  2.24 0.95 0.16
  140351  0 2 0.00  2.24 0.95 0.16
  180351  0 2 0.00  2.24 0.95 0.16
  220351  0 2 0.00  2.24 0.95 0.16
  260351  0 2 0.00  2.24 0.95 0.16
  100352  0 2 0.00  2.24 0.95 0.16
  140352  0 2 0.00  2.24 0.95 0.16
  180352  0 2 0.00  2.24 0.95 0.16
  220352  0 2 0.00  2.24 0.95 0.16
  260352  0 2 0.00  2.24 0.95 0.16
  100353  0 2 0.00  2.24 0.95 0.16
  140353  0 2 0.00  2.24 0.95 0.16
```

180353	0	2	0.00	2.24	0.95	0.16
220353	0	2	0.00	2.24	0.95	0.16
260353	0	2	0.00	2.24	0.95	0.16
100354	0	2	0.00	2.24	0.95	0.16
140354	0	2	0.00	2.24	0.95	0.16
180354	0	2	0.00	2.24	0.95	0.16
220354	0	2	0.00	2.24	0.95	0.16
260354	0	2	0.00	2.24	0.95	0.16
100355	0	2	0.00	2.24	0.95	0.16
140355	0	2	0.00	2.24	0.95	0.16
180355	0	2	0.00	2.24	0.95	0.16
220355	0	2	0.00	2.24	0.95	0.16
260355	0	2	0.00	2.24	0.95	0.16
100356	0	2	0.00	2.24	0.95	0.16
140356	0	2	0.00	2.24	0.95	0.16
180356	0	2	0.00	2.24	0.95	0.16
220356	0	2	0.00	2.24	0.95	0.16
260356	0	2	0.00	2.24	0.95	0.16
100357	0	2	0.00	2.24	0.95	0.16
140357	0	2	0.00	2.24	0.95	0.16
180357	0	2	0.00	2.24	0.95	0.16
220357	0	2	0.00	2.24	0.95	0.16
260357	0	2	0.00	2.24	0.95	0.16
100358	0	2	0.00	2.24	0.95	0.16
140358	0	2	0.00	2.24	0.95	0.16
180358	0	2	0.00	2.24	0.95	0.16
220358	0	2	0.00	2.24	0.95	0.16
260358	0	2	0.00	2.24	0.95	0.16
100359	0	2	0.00	2.24	0.95	0.16
140359	0	2	0.00	2.24	0.95	0.16
180359	0	2	0.00	2.24	0.95	0.16
220359	0	2	0.00	2.24	0.95	0.16
260359	0	2	0.00	2.24	0.95	0.16
100360	0	2	0.00	2.24	0.95	0.16
140360	0	2	0.00	2.24	0.95	0.16
180360	0	2	0.00	2.24	0.95	0.16
220360	0	2	0.00	2.24	0.95	0.16
260360	0	2	0.00	2.24	0.95	0.16
100361	0	2	0.00	2.24	0.95	0.16
140361	0	2	0.00	2.24	0.95	0.16
180361	0	2	0.00	2.24	0.95	0.16
220361	0	2	0.00	2.24	0.95	0.16
260361	0	2	0.00	2.24	0.95	0.16
100362	0	2	0.00	2.24	0.95	0.16
140362	0	2	0.00	2.24	0.95	0.16
180362	0	2	0.00	2.24	0.95	0.16
220362	0	2	0.00	2.24	0.95	0.16
260362	0	2	0.00	2.24	0.95	0.16
100363	0	2	0.00	2.24	0.95	0.16
140363	0	2	0.00	2.24	0.95	0.16

180363	0	2	0.00	2.24	0.95	0.16
220363	0	2	0.00	2.24	0.95	0.16
260363	0	2	0.00	2.24	0.95	0.16
100364	0	2	0.00	2.24	0.95	0.16
140364	0	2	0.00	2.24	0.95	0.16
180364	0	2	0.00	2.24	0.95	0.16
220364	0	2	0.00	2.24	0.95	0.16
260364	0	2	0.00	2.24	0.95	0.16
100365	0	2	0.00	2.24	0.95	0.16
140365	0	2	0.00	2.24	0.95	0.16
180365	0	2	0.00	2.24	0.95	0.16
220365	0	2	0.00	2.24	0.95	0.16
260365	0	2	0.00	2.24	0.95	0.16
100366	0	2	0.00	2.24	0.95	0.16
140366	0	2	0.00	2.24	0.95	0.16
180366	0	2	0.00	2.24	0.95	0.16
220366	0	2	0.00	2.24	0.95	0.16
260366	0	2	0.00	2.24	0.95	0.16
100367	0	2	0.00	2.24	0.95	0.16
140367	0	2	0.00	2.24	0.95	0.16
180367	0	2	0.00	2.24	0.95	0.16
220367	0	2	0.00	2.24	0.95	0.16
260367	0	2	0.00	2.24	0.95	0.16
100368	0	2	0.00	2.24	0.95	0.16
140368	0	2	0.00	2.24	0.95	0.16
180368	0	2	0.00	2.24	0.95	0.16
220368	0	2	0.00	2.24	0.95	0.16
260368	0	2	0.00	2.24	0.95	0.16
100369	0	2	0.00	2.24	0.95	0.16
140369	0	2	0.00	2.24	0.95	0.16
180369	0	2	0.00	2.24	0.95	0.16
220369	0	2	0.00	2.24	0.95	0.16
260369	0	2	0.00	2.24	0.95	0.16
100370	0	2	0.00	2.24	0.95	0.16
140370	0	2	0.00	2.24	0.95	0.16
180370	0	2	0.00	2.24	0.95	0.16
220370	0	2	0.00	2.24	0.95	0.16
260370	0	2	0.00	2.24	0.95	0.16
100371	0	2	0.00	2.24	0.95	0.16
140371	0	2	0.00	2.24	0.95	0.16
180371	0	2	0.00	2.24	0.95	0.16
220371	0	2	0.00	2.24	0.95	0.16
260371	0	2	0.00	2.24	0.95	0.16
100372	0	2	0.00	2.24	0.95	0.16
140372	0	2	0.00	2.24	0.95	0.16
180372	0	2	0.00	2.24	0.95	0.16
220372	0	2	0.00	2.24	0.95	0.16
260372	0	2	0.00	2.24	0.95	0.16
100373	0	2	0.00	2.24	0.95	0.16
140373	0	2	0.00	2.24	0.95	0.16

180373	0	2	0.00	2.24	0.95	0.16
220373	0	2	0.00	2.24	0.95	0.16
260373	0	2	0.00	2.24	0.95	0.16
100374	0	2	0.00	2.24	0.95	0.16
140374	0	2	0.00	2.24	0.95	0.16
180374	0	2	0.00	2.24	0.95	0.16
220374	0	2	0.00	2.24	0.95	0.16
260374	0	2	0.00	2.24	0.95	0.16
100375	0	2	0.00	2.24	0.95	0.16
140375	0	2	0.00	2.24	0.95	0.16
180375	0	2	0.00	2.24	0.95	0.16
220375	0	2	0.00	2.24	0.95	0.16
260375	0	2	0.00	2.24	0.95	0.16
100376	0	2	0.00	2.24	0.95	0.16
140376	0	2	0.00	2.24	0.95	0.16
180376	0	2	0.00	2.24	0.95	0.16
220376	0	2	0.00	2.24	0.95	0.16
260376	0	2	0.00	2.24	0.95	0.16
100377	0	2	0.00	2.24	0.95	0.16
140377	0	2	0.00	2.24	0.95	0.16
180377	0	2	0.00	2.24	0.95	0.16
220377	0	2	0.00	2.24	0.95	0.16
260377	0	2	0.00	2.24	0.95	0.16
100378	0	2	0.00	2.24	0.95	0.16
140378	0	2	0.00	2.24	0.95	0.16
180378	0	2	0.00	2.24	0.95	0.16
220378	0	2	0.00	2.24	0.95	0.16
260378	0	2	0.00	2.24	0.95	0.16
100379	0	2	0.00	2.24	0.95	0.16
140379	0	2	0.00	2.24	0.95	0.16
180379	0	2	0.00	2.24	0.95	0.16
220379	0	2	0.00	2.24	0.95	0.16
260379	0	2	0.00	2.24	0.95	0.16
100380	0	2	0.00	2.24	0.95	0.16
140380	0	2	0.00	2.24	0.95	0.16
180380	0	2	0.00	2.24	0.95	0.16
220380	0	2	0.00	2.24	0.95	0.16
260380	0	2	0.00	2.24	0.95	0.16
100381	0	2	0.00	2.24	0.95	0.16
140381	0	2	0.00	2.24	0.95	0.16
180381	0	2	0.00	2.24	0.95	0.16
220381	0	2	0.00	2.24	0.95	0.16
260381	0	2	0.00	2.24	0.95	0.16
100382	0	2	0.00	2.24	0.95	0.16
140382	0	2	0.00	2.24	0.95	0.16
180382	0	2	0.00	2.24	0.95	0.16
220382	0	2	0.00	2.24	0.95	0.16
260382	0	2	0.00	2.24	0.95	0.16
100383	0	2	0.00	2.24	0.95	0.16
140383	0	2	0.00	2.24	0.95	0.16

```
  180383  0 2 0.00  2.24 0.95 0.16
  220383  0 2 0.00  2.24 0.95 0.16
  260383  0 2 0.00  2.24 0.95 0.16
*** Record 17: Filtra., disposit. foliar pest. after harvest, and
plant uptake ***
     0.0       3     0.0
*** Record 18: Foliar dissipation parameters ***
     0.0     0.0    0.50
Cornelius silt loam, 15% slope, Hydrologic  Group: C
   148.0           0   0   0   0   0   0   0   0   0
*** Record 26: Soil volatilization constants ***
   0.0     0.0   0.0
*** Record 33 ***
       5
*** Record 34 ***
       1    15.0    1.30   0.329     0.0     0.0    0.0
*** Record 36: Soil half-life rate constants; repeat for each
horizon ***
           0.058   0.058   0.0
*** Record 37:  ***
             0.1   0.329   0.099    2.30    3.0
*** Record 39: Omitted; parent/daughter transformation rates ***
       2    13.0    1.38   0.338     0.0     0.0    0.0
           0.029   0.029   0.0
             1.0   0.338   0.108    1.11    3.0
       3    15.0    1.58   0.340     0.0     0.0    0.0
           0.029   0.029   0.0
             1.0   0.340   0.110    0.21    3.0
       4    55.0    1.52   0.358     0.0     0.0    0.0
           0.029   0.029   0.0
             5.0   0.358   0.148   0.145    3.0
       5    50.0    1.46   0.202     0.0     0.0    0.0
           0.029   0.029   0.0
             5.0   0.202   0.142    0.07    3.0
       0
            YEAR       5            YEAR       5            YEAR
    5   1
       1
       1  -----
       6    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    ESLS    TSER   0   0   1.0E3
    RFLX    TSER   0   0   1.0E5
    EFLX    TSER   0   0   1.0E5
    RZFX    TSER   0   0   1.0E5
```

Average Application Rate: Oregon Apples, Index Reservoir

```
*** PRZM 3.1 Input Data File; ORAPPLEX.INP; Modified April 5,
1998 ***
*** Modified for Carbaryl by Laurence Libelo, 6/21/00 ***
*** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE
VALUES on 2/28/01 ***
*** Crops simulated: Apples, Crabapples, and Quince ***
*** Location Washington County, Oregon; Meadow/Orchard Scenario;
MLRA: A2 ***
*** Manning's N: Assume sparse grass under mature trees (ca. 20
feet) ***
*** Temperature data read ***
*** This file is for scenario standardization; Reference chemical
is Atrazine ***
*** See ORAPPLEX.wpd for scenario details ***
Carbaryl
Cornelius silt loam, 15% slope, Hydrologic Group: C
   0.740   0.150       2  17.000       1       3
     9.2    10.3    11.8    13.6    15.30   15.3
    14.2    12.5    10.9     9.4     8.6     9.1
       4
    0.43    3.30     1.0    10.0     5.4       2   15.00   354.0
       1
       1    0.25    17.0 100.000       3  91  71  71
  0.0     600
       1       3
0103  0105  0112
0.01  0.01  0.01
0.015 0.015 0.015
      36
  010448  150548  151248       1
  010449  150549  151249       1
  010450  150550  151250       1
  010451  150551  151251       1
  010452  150552  151252       1
  010453  150553  151253       1
  010454  150554  151254       1
  010455  150555  151255       1
  010456  150556  151256       1
  010457  150557  151257       1
  010458  150558  151258       1
  010459  150559  151259       1
  010460  150560  151260       1
  010461  150561  151261       1
  010462  150562  151262       1
  010463  150563  151263       1
  010464  150564  151264       1
  010465  150565  151265       1
  010466  150566  151266       1
```

```
  010467  150567  151267       1
  010468  150568  151268       1
  010469  150569  151269       1
  010470  150570  151270       1
  010471  150571  151271       1
  010472  150572  151272       1
  010473  150573  151273       1
  010474  150574  151274       1
  010475  150575  151275       1
  010476  150576  151276       1
  010477  150577  151277       1
  010478  150578  151278       1
  010479  150579  151279       1
  010480  150580  151280       1
  010481  150581  151281       1
  010482  150582  151282       1
  010483  150583  151283       1
Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE VALUES
on 2/28/01  2 apps@1.2 lb/app ***
*** Aerial Application: 5 apps of 2 lb a.i./acre (3.3 kg/ha),
Aerial @ 95% eff. w/16% drift
      72       1       0       0
Chemical Kd: 3.0 (silt Loam soil); AeSM: T1/2: 12 days; AnSM:
T1/2 = 24 days
*** Record 16: Application information; set specific to carbaryl
***
  300448  0 2 0.00  1.34 0.95 0.16
  140548  0 2 0.00  1.34 0.95 0.16
  300449  0 2 0.00  1.34 0.95 0.16
  140549  0 2 0.00  1.34 0.95 0.16
  300450  0 2 0.00  1.34 0.95 0.16
  140550  0 2 0.00  1.34 0.95 0.16
  300451  0 2 0.00  1.34 0.95 0.16
  140551  0 2 0.00  1.34 0.95 0.16
  300452  0 2 0.00  1.34 0.95 0.16
  140552  0 2 0.00  1.34 0.95 0.16
  300453  0 2 0.00  1.34 0.95 0.16
  140553  0 2 0.00  1.34 0.95 0.16
  300454  0 2 0.00  1.34 0.95 0.16
  140554  0 2 0.00  1.34 0.95 0.16
  300455  0 2 0.00  1.34 0.95 0.16
  140555  0 2 0.00  1.34 0.95 0.16
  300456  0 2 0.00  1.34 0.95 0.16
  140556  0 2 0.00  1.34 0.95 0.16
  300457  0 2 0.00  1.34 0.95 0.16
  140557  0 2 0.00  1.34 0.95 0.16
  300458  0 2 0.00  1.34 0.95 0.16
  140558  0 2 0.00  1.34 0.95 0.16
  300459  0 2 0.00  1.34 0.95 0.16
  140559  0 2 0.00  1.34 0.95 0.16
```

300460	0	2	0.00	1.34	0.95	0.16
140560	0	2	0.00	1.34	0.95	0.16
300461	0	2	0.00	1.34	0.95	0.16
140561	0	2	0.00	1.34	0.95	0.16
300462	0	2	0.00	1.34	0.95	0.16
140562	0	2	0.00	1.34	0.95	0.16
300463	0	2	0.00	1.34	0.95	0.16
140563	0	2	0.00	1.34	0.95	0.16
300464	0	2	0.00	1.34	0.95	0.16
140564	0	2	0.00	1.34	0.95	0.16
300465	0	2	0.00	1.34	0.95	0.16
140565	0	2	0.00	1.34	0.95	0.16
300466	0	2	0.00	1.34	0.95	0.16
140566	0	2	0.00	1.34	0.95	0.16
300467	0	2	0.00	1.34	0.95	0.16
140567	0	2	0.00	1.34	0.95	0.16
300468	0	2	0.00	1.34	0.95	0.16
140568	0	2	0.00	1.34	0.95	0.16
300469	0	2	0.00	1.34	0.95	0.16
140569	0	2	0.00	1.34	0.95	0.16
300470	0	2	0.00	1.34	0.95	0.16
140570	0	2	0.00	1.34	0.95	0.16
300471	0	2	0.00	1.34	0.95	0.16
140571	0	2	0.00	1.34	0.95	0.16
300472	0	2	0.00	1.34	0.95	0.16
140572	0	2	0.00	1.34	0.95	0.16
300473	0	2	0.00	1.34	0.95	0.16
140573	0	2	0.00	1.34	0.95	0.16
300474	0	2	0.00	1.34	0.95	0.16
140574	0	2	0.00	1.34	0.95	0.16
300475	0	2	0.00	1.34	0.95	0.16
140575	0	2	0.00	1.34	0.95	0.16
300476	0	2	0.00	1.34	0.95	0.16
140576	0	2	0.00	1.34	0.95	0.16
300477	0	2	0.00	1.34	0.95	0.16
140577	0	2	0.00	1.34	0.95	0.16
300478	0	2	0.00	1.34	0.95	0.16
140578	0	2	0.00	1.34	0.95	0.16
300479	0	2	0.00	1.34	0.95	0.16
140579	0	2	0.00	1.34	0.95	0.16
300480	0	2	0.00	1.34	0.95	0.16
140580	0	2	0.00	1.34	0.95	0.16
300481	0	2	0.00	1.34	0.95	0.16
140581	0	2	0.00	1.34	0.95	0.16
300482	0	2	0.00	1.34	0.95	0.16
140582	0	2	0.00	1.34	0.95	0.16
300483	0	2	0.00	1.34	0.95	0.16
140583	0	2	0.00	1.34	0.95	0.16

```
*** Record 17: Filtra., disposit. foliar pest. after harvest, and
plant uptake ***
     0.0       3     0.0
*** Record 18: Foliar dissipation parameters ***
     0.0     0.0    0.50
Cornelius silt loam, 15% slope, Hydrologic  Group: C
   148.0           0   0   0   0   0   0   0   0   0
*** Record 26: Soil volatilization constants ***
   0.0     0.0   0.0
*** Record 33 ***
       5
*** Record 34 ***
       1    15.0    1.30   0.329     0.0     0.0    0.0
*** Record 36: Soil half-life rate constants; repeat for each
horizon ***
           0.058   0.058   0.0
*** Record 37:  ***
             0.1   0.329   0.099    2.30    3.0
*** Record 39: Omitted; parent/daughter transformation rates ***
       2    13.0    1.38   0.338     0.0     0.0    0.0
           0.029   0.029   0.0
             1.0   0.338   0.108    1.11    3.0
       3    15.0    1.58   0.340     0.0     0.0    0.0
           0.029   0.029   0.0
             1.0   0.340   0.110    0.21    3.0
       4    55.0    1.52   0.358     0.0     0.0    0.0
           0.029   0.029   0.0
             5.0   0.358   0.148   0.145    3.0
       5    50.0    1.46   0.202     0.0     0.0    0.0
           0.029   0.029   0.0
             5.0   0.202   0.142    0.07    3.0
       0
            YEAR       5            YEAR       5            YEAR
    5   1
       1
       1  -----
       6    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    ESLS    TSER   0   0   1.0E3
    RFLX    TSER   0   0   1.0E5
    EFLX    TSER   0   0   1.0E5
    RZFX    TSER   0   0   1.0E5
```

Maximum Reported Application Rate: Oregon Apples, Index Reservoir

```
*** PRZM 3.1 Input Data File; ORAPPLEX.INP; Modified April 5,
1998 ***
*** Modified for Carbaryl by Laurence Libelo, 6/21/00
*** Modified for Index Res. by Laurence Libelo, 3/7/01
*** Crops simulated: Apples, Crabapples, and Quince ***
*** Location Washington County, Oregon; Meadow/Orchard Scenario;
MLRA: A2 ***
*** Manning's N: Assume sparse grass under mature trees (ca. 20
feet) ***
*** Temperature data read ***
*** This file is for scenario standardization; Reference chemical
is Atrazine ***
*** See ORAPPLEX.wpd for scenario details ***
Carbaryl
Cornelius silt loam, 15% slope, Hydrologic Group: C
   0.740   0.150       2  17.000       1       3
     9.2    10.3    11.8    13.6   15.30   15.3
    14.2    12.5    10.9     9.4     8.6     9.1
       4
    0.43    3.30     1.0   172.8     5.4       2   15.00   464
       1
       1    0.25    17.0 100.000       3  91  71  71
  0.0     600
       1       3
0103  0105  0112
0.01  0.01  0.01
0.015 0.015 0.015
      36
  010448  150548  151248       1
  010449  150549  151249       1
  010450  150550  151250       1
  010451  150551  151251       1
  010452  150552  151252       1
  010453  150553  151253       1
  010454  150554  151254       1
  010455  150555  151255       1
  010456  150556  151256       1
  010457  150557  151257       1
  010458  150558  151258       1
  010459  150559  151259       1
  010460  150560  151260       1
  010461  150561  151261       1
  010462  150562  151262       1
  010463  150563  151263       1
  010464  150564  151264       1
  010465  150565  151265       1
  010466  150566  151266       1
  010467  150567  151267       1
```

```
  010468  150568  151268       1
  010469  150569  151269       1
  010470  150570  151270       1
  010471  150571  151271       1
  010472  150572  151272       1
  010473  150573  151273       1
  010474  150574  151274       1
  010475  150575  151275       1
  010476  150576  151276       1
  010477  150577  151277       1
  010478  150578  151278       1
  010479  150579  151279       1
  010480  150580  151280       1
  010481  150581  151281       1
  010482  150582  151282       1
  010483  150583  151283       1
Max reported rate - 2 apps @ 1.6 lb A.I./acre
*** Aerial Application: 5 apps of 2 lb a.i./acre (2.2 kg/ha),
Aerial @ 95% eff. w/16% drift
      72       1       0       0
Chemical Kd: 3.0 (silt Loam soil); AeSM: T1/2: 12 days; AnSM:
T1/2 = 24 days
*** Record 16: Application information; set specific to carbaryl
***
  300448  0 2 0.00  1.79 0.95 0.16
  140548  0 2 0.00  1.79 0.95 0.16
  300449  0 2 0.00  1.79 0.95 0.16
  140549  0 2 0.00  1.79 0.95 0.16
  300450  0 2 0.00  1.79 0.95 0.16
  140550  0 2 0.00  1.79 0.95 0.16
  300451  0 2 0.00  1.79 0.95 0.16
  140551  0 2 0.00  1.79 0.95 0.16
  300452  0 2 0.00  1.79 0.95 0.16
  140552  0 2 0.00  1.79 0.95 0.16
  300453  0 2 0.00  1.79 0.95 0.16
  140553  0 2 0.00  1.79 0.95 0.16
  300454  0 2 0.00  1.79 0.95 0.16
  140554  0 2 0.00  1.79 0.95 0.16
  300455  0 2 0.00  1.79 0.95 0.16
  140555  0 2 0.00  1.79 0.95 0.16
  300456  0 2 0.00  1.79 0.95 0.16
  140556  0 2 0.00  1.79 0.95 0.16
  300457  0 2 0.00  1.79 0.95 0.16
  140557  0 2 0.00  1.79 0.95 0.16
  300458  0 2 0.00  1.79 0.95 0.16
  140558  0 2 0.00  1.79 0.95 0.16
  300459  0 2 0.00  1.79 0.95 0.16
  140559  0 2 0.00  1.79 0.95 0.16
  300460  0 2 0.00  1.79 0.95 0.16
  140560  0 2 0.00  1.79 0.95 0.16
```

```
  300461  0 2 0.00  1.79 0.95 0.16
  140561  0 2 0.00  1.79 0.95 0.16
  300462  0 2 0.00  1.79 0.95 0.16
  140562  0 2 0.00  1.79 0.95 0.16
  300463  0 2 0.00  1.79 0.95 0.16
  140563  0 2 0.00  1.79 0.95 0.16
  300464  0 2 0.00  1.79 0.95 0.16
  140564  0 2 0.00  1.79 0.95 0.16
  300465  0 2 0.00  1.79 0.95 0.16
  140565  0 2 0.00  1.79 0.95 0.16
  300466  0 2 0.00  1.79 0.95 0.16
  140566  0 2 0.00  1.79 0.95 0.16
  300467  0 2 0.00  1.79 0.95 0.16
  140567  0 2 0.00  1.79 0.95 0.16
  300468  0 2 0.00  1.79 0.95 0.16
  140568  0 2 0.00  1.79 0.95 0.16
  300469  0 2 0.00  1.79 0.95 0.16
  140569  0 2 0.00  1.79 0.95 0.16
  300470  0 2 0.00  1.79 0.95 0.16
  140570  0 2 0.00  1.79 0.95 0.16
  300471  0 2 0.00  1.79 0.95 0.16
  140571  0 2 0.00  1.79 0.95 0.16
  300472  0 2 0.00  1.79 0.95 0.16
  140572  0 2 0.00  1.79 0.95 0.16
  300473  0 2 0.00  1.79 0.95 0.16
  140573  0 2 0.00  1.79 0.95 0.16
  300474  0 2 0.00  1.79 0.95 0.16
  140574  0 2 0.00  1.79 0.95 0.16
  300475  0 2 0.00  1.79 0.95 0.16
  140575  0 2 0.00  1.79 0.95 0.16
  300476  0 2 0.00  1.79 0.95 0.16
  140576  0 2 0.00  1.79 0.95 0.16
  300477  0 2 0.00  1.79 0.95 0.16
  140577  0 2 0.00  1.79 0.95 0.16
  300478  0 2 0.00  1.79 0.95 0.16
  140578  0 2 0.00  1.79 0.95 0.16
  300479  0 2 0.00  1.79 0.95 0.16
  140579  0 2 0.00  1.79 0.95 0.16
  300480  0 2 0.00  1.79 0.95 0.16
  140580  0 2 0.00  1.79 0.95 0.16
  300481  0 2 0.00  1.79 0.95 0.16
  140581  0 2 0.00  1.79 0.95 0.16
  300482  0 2 0.00  1.79 0.95 0.16
  140582  0 2 0.00  1.79 0.95 0.16
  300483  0 2 0.00  1.79 0.95 0.16
  140583  0 2 0.00  1.79 0.95 0.16

*** Record 17: Filtra., disposit. foliar pest. after harvest, and
plant uptake ***
     0.0       3     0.0
```

```
*** Record 18: Foliar dissipation parameters ***
     0.0     0.0    0.50
Cornelius silt loam, 15% slope, Hydrologic  Group: C
   148.0           0   0   0   0   0   0   0   0   0
*** Record 26: Soil volatilization constants ***
   0.0     0.0   0.0
*** Record 33 ***
       5
*** Record 34 ***
       1    15.0    1.30   0.329     0.0     0.0    0.0
*** Record 36: Soil half-life rate constants; repeat for each
horizon ***
           0.058   0.058   0.0
*** Record 37:  ***
             0.1   0.329   0.099    2.30    3.0
*** Record 39: Omitted; parent/daughter transformation rates ***
       2    13.0    1.38   0.338     0.0     0.0    0.0
           0.029   0.029   0.0
             1.0   0.338   0.108    1.11    3.0
       3    15.0    1.58   0.340     0.0     0.0    0.0
           0.029   0.029   0.0
             1.0   0.340   0.110    0.21    3.0
       4    55.0    1.52   0.358     0.0     0.0    0.0
           0.029   0.029   0.0
             5.0   0.358   0.148   0.145    3.0
       5    50.0    1.46   0.202     0.0     0.0    0.0
           0.029   0.029   0.0
             5.0   0.202   0.142    0.07    3.0
       0
            YEAR       5            YEAR       5            YEAR
    5   1
       1
       1  -----
       6    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    ESLS    TSER   0   0   1.0E3
    RFLX    TSER   0   0   1.0E5
    EFLX    TSER   0   0   1.0E5
    RZFX    TSER   0   0   1.0E5
```

Maximum Application Rate: Sugar beets, Index Reservoir

```
*** PRZM2 Version 3.12 Input Data File ***
*** MNSUGAR1.inp Index Reservoir Scenario created on 12/13/99 ***
*** Modified for CABRBARYL 6/21/00 by Laurence Libelo ***
*** Bearden soil is a Benchmark soil with ca. 800K mapped acres
in MLRA ***
*** Sugar beets, conventional tillage ***
*** Highest acreage sugarbeet state is MN; highest county in MN
is Polk ***
*** Manning's N value set to 0.02 for residues applied to fallow
surfaces ***
*** Application timing information provided by Russ Severson (?),
*** University of Minnesota Agricultural Extension Service, Polk
County, MN,
*** (218) 281-8696
*** PCA for sugarbeets not available, use default PCA of 0.87 ***
Chemical: Carbaryl
Bearden Silty Clay Loam; HYGP: C; MLRA F-56, Polk County,
Minnesota
   0.760   0.500       0   12.00       1       3
       4
    0.28    0.12    0.50  172.80               3    3.00    600.0
       1
       1    0.10   20.00   80.00       3  91  82  91
 0.00   100.00
       1       3
0101 1605 1110
0.43 0.18 0.43
0.02 0.02 0.02
      36
  160548  061048  161048       1
  160549  061049  161049       1
  160550  061050  161050       1
  160551  061051  161051       1
  160552  061052  161052       1
  160553  061053  161053       1
  160554  061054  161054       1
  160555  061055  161055       1
  160556  061056  161056       1
  160557  061057  161057       1
  160558  061058  161058       1
  160559  061059  161059       1
  160560  061060  161060       1
  160561  061061  161061       1
  160562  061062  161062       1
  160563  061063  161063       1
  160564  061064  161064       1
  160565  061065  161065       1
```

```
  160566  061066  161066       1
  160567  061067  161067       1
  160568  061068  161068       1
  160569  061069  161069       1
  160570  061070  161070       1
  160571  061071  161071       1
  160572  061072  161072       1
  160573  061073  161073       1
  160574  061074  161074       1
  160575  061075  161075       1
  160576  061076  161076       1
  160577  061077  161077       1
  160578  061078  161078       1
  160579  061079  161079       1
  160580  061080  161080       1
  160581  061081  161081       1
  160582  061082  161082       1
  160583  061083  161083       1
Application Schedule: 2 aerial app @ 1.5 lb a.i./ acre (1.68
kg/ha, 95% app. eff, 16% spray drift
      72       1       0       0
Carbaryl: Kd: 3.0; AeSM: T1/2 = 12 days; AnSM: T1/2 = 24 days
  300448  0 2 0.00  1.68 0.95 0.16
  140548  0 2 0.00  1.68 0.95 0.16
  300449  0 2 0.00  1.68 0.95 0.16
  140549  0 2 0.00  1.68 0.95 0.16
  300450  0 2 0.00  1.68 0.95 0.16
  140550  0 2 0.00  1.68 0.95 0.16
  300451  0 2 0.00  1.68 0.95 0.16
  140551  0 2 0.00  1.68 0.95 0.16
  300452  0 2 0.00  1.68 0.95 0.16
  140552  0 2 0.00  1.68 0.95 0.16
  300453  0 2 0.00  1.68 0.95 0.16
  140553  0 2 0.00  1.68 0.95 0.16
  300454  0 2 0.00  1.68 0.95 0.16
  140554  0 2 0.00  1.68 0.95 0.16
  300455  0 2 0.00  1.68 0.95 0.16
  140555  0 2 0.00  1.68 0.95 0.16
  300456  0 2 0.00  1.68 0.95 0.16
  140556  0 2 0.00  1.68 0.95 0.16
  300457  0 2 0.00  1.68 0.95 0.16
  140557  0 2 0.00  1.68 0.95 0.16
  300458  0 2 0.00  1.68 0.95 0.16
  140558  0 2 0.00  1.68 0.95 0.16
  300459  0 2 0.00  1.68 0.95 0.16
  140559  0 2 0.00  1.68 0.95 0.16
  300460  0 2 0.00  1.68 0.95 0.16
  140560  0 2 0.00  1.68 0.95 0.16
  300461  0 2 0.00  1.68 0.95 0.16
  140561  0 2 0.00  1.68 0.95 0.16
```

```
  300462  0 2 0.00  1.68 0.95 0.16
  140562  0 2 0.00  1.68 0.95 0.16
  300463  0 2 0.00  1.68 0.95 0.16
  140563  0 2 0.00  1.68 0.95 0.16
  300464  0 2 0.00  1.68 0.95 0.16
  140564  0 2 0.00  1.68 0.95 0.16
  300465  0 2 0.00  1.68 0.95 0.16
  140565  0 2 0.00  1.68 0.95 0.16
  300466  0 2 0.00  1.68 0.95 0.16
  140566  0 2 0.00  1.68 0.95 0.16
  300467  0 2 0.00  1.68 0.95 0.16
  140567  0 2 0.00  1.68 0.95 0.16
  300468  0 2 0.00  1.68 0.95 0.16
  140568  0 2 0.00  1.68 0.95 0.16
  300469  0 2 0.00  1.68 0.95 0.16
  140569  0 2 0.00  1.68 0.95 0.16
  300470  0 2 0.00  1.68 0.95 0.16
  140570  0 2 0.00  1.68 0.95 0.16
  300471  0 2 0.00  1.68 0.95 0.16
  140571  0 2 0.00  1.68 0.95 0.16
  300472  0 2 0.00  1.68 0.95 0.16
  140572  0 2 0.00  1.68 0.95 0.16
  300473  0 2 0.00  1.68 0.95 0.16
  140573  0 2 0.00  1.68 0.95 0.16
  300474  0 2 0.00  1.68 0.95 0.16
  140574  0 2 0.00  1.68 0.95 0.16
  300475  0 2 0.00  1.68 0.95 0.16
  140575  0 2 0.00  1.68 0.95 0.16
  300476  0 2 0.00  1.68 0.95 0.16
  140576  0 2 0.00  1.68 0.95 0.16
  300477  0 2 0.00  1.68 0.95 0.16
  140577  0 2 0.00  1.68 0.95 0.16
  300478  0 2 0.00  1.68 0.95 0.16
  140578  0 2 0.00  1.68 0.95 0.16
  300479  0 2 0.00  1.68 0.95 0.16
  140579  0 2 0.00  1.68 0.95 0.16
  300480  0 2 0.00  1.68 0.95 0.16
  140580  0 2 0.00  1.68 0.95 0.16
  300481  0 2 0.00  1.68 0.95 0.16
  140581  0 2 0.00  1.68 0.95 0.16
  300482  0 2 0.00  1.68 0.95 0.16
  140582  0 2 0.00  1.68 0.95 0.16
  300483  0 2 0.00  1.68 0.95 0.16
  140583  0 2 0.00  1.68 0.95 0.16
     0.0       3    0.00
     0.0    0.00    0.50
Bearden Silty Clay Loam; Hydrologic Group C;
  100.00           0   0   0   0   0   0   0   0   0
    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
 0.00
```

```
       4
       1   10.00   1.400   0.377   0.000   0.000
           0.58    0.58    0.00
            0.10   0.377   0.207   1.160    3.0
       2    8.00   1.400   0.377   0.000   0.000
           0.029   0.029   0.00
            1.00   0.377   0.207   1.160    3.0
       3   54.00   1.500   0.292   0.000   0.000
           0.029   0.029   0.00
            2.00   0.292   0.132   1.160    3.0
       4   28.00   1.800   0.285   0.000   0.000
           0.029   0.029   0.00
             2.0   0.285   0.125   0.174    3.0
       0
            YEAR       5            YEAR       5            YEAR
    5   1
       1
       1  -----
       1    YEAR
*** PRCP    TSER   0   0***
    RUNF    TCUM   0   0
*** ESLS    TSER   0   0   1.0E3***
*** RFLX    TSER   0   0   1.0E5***
*** EFLX    TSER   0   0   1.0E5***
*** RZFX    TSER   0   0   1.0E5***
```

Average Application Rate: Sugar beets, Index Reservoir

```
*** PRZM2 Version 3.12 Input Data File ***
*** MNSUGAR1.inp Index Reservoir Scenario created on 12/13/99 ***
*** Modified for CABRBARYL 6/21/00 by Laurence Libelo ***
*** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE
VALUES on 2/28/01 ***
*** Bearden soil is a Benchmark soil with ca. 800K mapped acres
in MLRA ***
*** Sugar beets, conventional tillage ***
*** Highest acreage sugarbeet state is MN; highest county in MN
is Polk ***
*** Manning's N value set to 0.02 for residues applied to fallow
surfaces ***
*** Application timing information provided by Russ Severson (?),
*** University of Minnesota Agricultural Extension Service, Polk
County, MN,
*** (218) 281-8696
*** PCA for sugarbeets not available, use default PCA of 0.87 ***
Chemical: Carbaryl
Bearden Silty Clay Loam; HYGP: C; MLRA F-56, Polk County,
Minnesota
   0.760   0.500       0   12.00       1       3
       4
    0.28    0.12    0.50  172.80               3    3.00    600.0
       1
       1    0.10   20.00   80.00       3  91  82  91
 0.00   100.00
       1       3
0101 1605 1110
0.43 0.18 0.43
0.02 0.02 0.02
      36
  160548  061048  161048       1
  160549  061049  161049       1
  160550  061050  161050       1
  160551  061051  161051       1
  160552  061052  161052       1
  160553  061053  161053       1
  160554  061054  161054       1
  160555  061055  161055       1
  160556  061056  161056       1
  160557  061057  161057       1
  160558  061058  161058       1
  160559  061059  161059       1
  160560  061060  161060       1
  160561  061061  161061       1
  160562  061062  161062       1
  160563  061063  161063       1
  160564  061064  161064       1
```

```
  160565  061065  161065       1
  160566  061066  161066       1
  160567  061067  161067       1
  160568  061068  161068       1
  160569  061069  161069       1
  160570  061070  161070       1
  160571  061071  161071       1
  160572  061072  161072       1
  160573  061073  161073       1
  160574  061074  161074       1
  160575  061075  161075       1
  160576  061076  161076       1
  160577  061077  161077       1
  160578  061078  161078       1
  160579  061079  161079       1
  160580  061080  161080       1
  160581  061081  161081       1
  160582  061082  161082       1
  160583  061083  161083       1
Application Schedule: 1 aerial app @ 1.5 lb a.i./ acre (1.68
kg/ha, 95% app. eff, 5% spray drift ***
*** Application Schedule: 2 aerial app @ 1.5 lb a.i./ acre (1.68
kg/ha, 95% app. eff, 16% spray drift
      36       1       0       0
Carbaryl: Kd: 3.0; AeSM: T1/2 = 12 days; AnSM: T1/2 = 24 days
  300448  0 2 0.00  1.68 0.95 0.16
  300449  0 2 0.00  1.68 0.95 0.16
  300450  0 2 0.00  1.68 0.95 0.16
  300451  0 2 0.00  1.68 0.95 0.16
  300452  0 2 0.00  1.68 0.95 0.16
  300453  0 2 0.00  1.68 0.95 0.16
  300454  0 2 0.00  1.68 0.95 0.16
  300455  0 2 0.00  1.68 0.95 0.16
  300456  0 2 0.00  1.68 0.95 0.16
  300457  0 2 0.00  1.68 0.95 0.16
  300458  0 2 0.00  1.68 0.95 0.16
  300459  0 2 0.00  1.68 0.95 0.16
  300460  0 2 0.00  1.68 0.95 0.16
  300461  0 2 0.00  1.68 0.95 0.16
  300462  0 2 0.00  1.68 0.95 0.16
  300463  0 2 0.00  1.68 0.95 0.16
  300464  0 2 0.00  1.68 0.95 0.16
  300465  0 2 0.00  1.68 0.95 0.16
  300466  0 2 0.00  1.68 0.95 0.16
  300467  0 2 0.00  1.68 0.95 0.16
  300468  0 2 0.00  1.68 0.95 0.16
  300469  0 2 0.00  1.68 0.95 0.16
  300470  0 2 0.00  1.68 0.95 0.16
  300471  0 2 0.00  1.68 0.95 0.16
  300472  0 2 0.00  1.68 0.95 0.16
```

```
  300473  0 2 0.00  1.68 0.95 0.16
  300474  0 2 0.00  1.68 0.95 0.16
  300475  0 2 0.00  1.68 0.95 0.16
  300476  0 2 0.00  1.68 0.95 0.16
  300477  0 2 0.00  1.68 0.95 0.16
  300478  0 2 0.00  1.68 0.95 0.16
  300479  0 2 0.00  1.68 0.95 0.16
  300480  0 2 0.00  1.68 0.95 0.16
  300481  0 2 0.00  1.68 0.95 0.16
  300482  0 2 0.00  1.68 0.95 0.16
  300483  0 2 0.00  1.68 0.95 0.16
     0.0       3    0.00
     0.0    0.00    0.50
Bearden Silty Clay Loam; Hydrologic Group C;
  100.00           0   0   0   0   0   0   0   0   0
    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
 0.00
       4
       1   10.00   1.400   0.377   0.000   0.000
           0.58    0.58    0.00
            0.10   0.377   0.207   1.160    3.0
       2    8.00   1.400   0.377   0.000   0.000
           0.029   0.029   0.00
            1.00   0.377   0.207   1.160    3.0
       3   54.00   1.500   0.292   0.000   0.000
           0.029   0.029   0.00
            2.00   0.292   0.132   1.160    3.0
       4   28.00   1.800   0.285   0.000   0.000
           0.029   0.029   0.00
             2.0   0.285   0.125   0.174    3.0
       0
            YEAR       5            YEAR       5            YEAR
    5   1
       1
       1  -----
       1    YEAR
*** PRCP    TSER   0   0***
    RUNF    TCUM   0   0
*** ESLS    TSER   0   0   1.0E3***
*** RFLX    TSER   0   0   1.0E5***
*** EFLX    TSER   0   0   1.0E5***
*** RZFX    TSER   0   0   1.0E5***
```

Maximum Reported Application Rate: Sugar beets, Index Reservoir

```
*** PRZM2 Version 3.12 Input Data File ***
*** MNSUGAR1.inp Index Reservoir Scenario created on 12/13/99 ***
*** Modified for CABRBARYL 6/21/00 by Laurence Libelo ***
*** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE
VALUES on 2/28/01 ***
*** Bearden soil is a Benchmark soil with ca. 800K mapped acres
in MLRA ***
*** Sugar beets, conventional tillage ***
*** Highest acreage sugarbeet state is MN; highest county in MN
is Polk ***
*** Manning's N value set to 0.02 for residues applied to fallow
surfaces ***
*** Application timing information provided by Russ Severson (?),
*** University of Minnesota Agricultural Extension Service, Polk
County, MN,
*** (218) 281-8696
*** PCA for sugarbeets not available, use default PCA of 0.87 ***
Chemical: Carbaryl
Bearden Silty Clay Loam; HYGP: C; MLRA F-56, Polk County,
Minnesota
   0.760   0.500       0   12.00       1       3
       4
    0.28    0.12    0.50  172.80               3    3.00    600.0
       1
       1    0.10   20.00   80.00       3  91  82  91
  0.00   100.00
       1       3
0101 1605 1110
0.43 0.18 0.43
0.02 0.02 0.02
      36
  160548  061048  161048       1
  160549  061049  161049       1
  160550  061050  161050       1
  160551  061051  161051       1
  160552  061052  161052       1
  160553  061053  161053       1
  160554  061054  161054       1
  160555  061055  161055       1
  160556  061056  161056       1
  160557  061057  161057       1
  160558  061058  161058       1
  160559  061059  161059       1
  160560  061060  161060       1
  160561  061061  161061       1
  160562  061062  161062       1
  160563  061063  161063       1
  160564  061064  161064       1
  160565  061065  161065       1
```

```
  160566  061066  161066       1
  160567  061067  161067       1
  160568  061068  161068       1
  160569  061069  161069       1
  160570  061070  161070       1
  160571  061071  161071       1
  160572  061072  161072       1
  160573  061073  161073       1
  160574  061074  161074       1
  160575  061075  161075       1
  160576  061076  161076       1
  160577  061077  161077       1
  160578  061078  161078       1
  160579  061079  161079       1
  160580  061080  161080       1
  160581  061081  161081       1
  160582  061082  161082       1
  160583  061083  161083       1
Maximum raported application rate: 1 app @ 1.2 lb A.I./acre
*** Application Schedule: 2 aerial app @ 1.5 lb a.i./ acre (1.68
kg/ha, 95% app. eff, 16% spray drift
      36       1       0       0
Carbaryl: Kd: 3.0; AeSM: T1/2 = 12 days; AnSM: T1/2 = 24 days
  300448  0 2 0.00  1.34 0.95 0.16
  300449  0 2 0.00  1.34 0.95 0.16
  300450  0 2 0.00  1.34 0.95 0.16
  300451  0 2 0.00  1.34 0.95 0.16
  300452  0 2 0.00  1.34 0.95 0.16
  300453  0 2 0.00  1.34 0.95 0.16
  300454  0 2 0.00  1.34 0.95 0.16
  300455  0 2 0.00  1.34 0.95 0.16
  300456  0 2 0.00  1.34 0.95 0.16
  300457  0 2 0.00  1.34 0.95 0.16
  300458  0 2 0.00  1.34 0.95 0.16
  300459  0 2 0.00  1.34 0.95 0.16
  300460  0 2 0.00  1.34 0.95 0.16
  300461  0 2 0.00  1.34 0.95 0.16
  300462  0 2 0.00  1.34 0.95 0.16
  300463  0 2 0.00  1.34 0.95 0.16
  300464  0 2 0.00  1.34 0.95 0.16
  300465  0 2 0.00  1.34 0.95 0.16
  300466  0 2 0.00  1.34 0.95 0.16
  300467  0 2 0.00  1.34 0.95 0.16
  300468  0 2 0.00  1.34 0.95 0.16
  300469  0 2 0.00  1.34 0.95 0.16
  300470  0 2 0.00  1.34 0.95 0.16
  300471  0 2 0.00  1.34 0.95 0.16
  300472  0 2 0.00  1.34 0.95 0.16
  300473  0 2 0.00  1.34 0.95 0.16
  300474  0 2 0.00  1.34 0.95 0.16
  300475  0 2 0.00  1.34 0.95 0.16
```

```
  300476  0 2 0.00  1.34 0.95 0.16
  300477  0 2 0.00  1.34 0.95 0.16
  300478  0 2 0.00  1.34 0.95 0.16
  300479  0 2 0.00  1.34 0.95 0.16
  300480  0 2 0.00  1.34 0.95 0.16
  300481  0 2 0.00  1.34 0.95 0.16
  300482  0 2 0.00  1.34 0.95 0.16
  300483  0 2 0.00  1.34 0.95 0.16

     0.0       3    0.00
     0.0    0.00    0.50
Bearden Silty Clay Loam; Hydrologic Group C;
  100.00           0   0   0   0   0   0   0   0   0
    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
 0.00
       4
       1   10.00   1.400   0.377   0.000   0.000
           0.58    0.58    0.00
            0.10   0.377   0.207   1.160    3.0
       2    8.00   1.400   0.377   0.000   0.000
           0.029   0.029   0.00
            1.00   0.377   0.207   1.160    3.0
       3   54.00   1.500   0.292   0.000   0.000
           0.029   0.029   0.00
            2.00   0.292   0.132   1.160    3.0
       4   28.00   1.800   0.285   0.000   0.000
           0.029   0.029   0.00
             2.0   0.285   0.125   0.174    3.0
       0
            YEAR       5             YEAR       5             YEAR
    5   1
       1
       1  -----
       1    YEAR
*** PRCP    TSER   0   0***
    RUNF    TCUM   0   0
*** ESLS    TSER   0   0   1.0E3***
*** RFLX    TSER   0   0   1.0E5***
*** EFLX    TSER   0   0   1.0E5***
*** RZFX    TSER   0   0   1.0E5***
```

Maximum Application Rate: Florida Citrus, Index Reservoir

```
PRZM3 Input File, flcit.inp (Jan 28 2000)
*** original file source unknown ***
*** Source of crop and soil data unknown ***
*** modified for carbaryl by Laurence Libelo, 6/21/00 ***
Location: Osceola County, FL.; Crop: citrus; MLRA 156A
    0.77    0.15       0   25.00       1       1
       4
    0.10    0.13    1.00   172.8               3   1.00   600.0
       1
       1    0.10  100.00   80.00       3  94  84  89    0.00
100.00
       1       3
0101 21 9 2209
0.10 0.10 0.10
.023 .023 .023
      36
  110548  170748   10848       1
  110549  170749   10849       1
  110550  170750   10850       1
  110551  170751   10851       1
  110552  170752   10852       1
  110553  170753   10853       1
  110554  170754   10854       1
  110555  170755   10855       1
  110556  170756   10856       1
  110557  170757   10857       1
  110558  170758   10858       1
  110559  170759   10859       1
  110560  170760   10860       1
  110561  170761   10861       1
  110562  170762   10862       1
  110563  170763   10863       1
  110564  170764   10864       1
  110565  170765   10865       1
  110566  170766   10866       1
  110567  170767   10867       1
  110568  170768   10868       1
  110569  170769   10869       1
  110570  170770   10870       1
  110571  170771   10871       1
  110572  170772   10872       1
  110573  170773   10873       1
  110574  170774   10874       1
  110575  170775   10875       1
  110576  170776   10876       1
  110577  170777   10877       1
  110578  170778   10878       1
  110579  170779   10879       1
  110580  170780   10880       1
```

```
  110581  170781   10881        1
  110582  170782   10882        1
  110583  170783   10883        1
Application: 4 aerial appls @ 5 lb a.i./ac/year (5.6 kg/ha) @95%
eff, w/16%drift
     144       1       0       0
CARBARYL on FL Cirtus
  300448  0 2 0.00  5.60 0.95 0.16
  140548  0 2 0.00  5.60 0.95 0.16
  280548  0 2 0.00  5.60 0.95 0.16
  110648  0 2 0.00  5.60 0.95 0.16
  300449  0 2 0.00  5.60 0.95 0.16
  140549  0 2 0.00  5.60 0.95 0.16
  280549  0 2 0.00  5.60 0.95 0.16
  110649  0 2 0.00  5.60 0.95 0.16
  300450  0 2 0.00  5.60 0.95 0.16
  140550  0 2 0.00  5.60 0.95 0.16
  280550  0 2 0.00  5.60 0.95 0.16
  110650  0 2 0.00  5.60 0.95 0.16
  300451  0 2 0.00  5.60 0.95 0.16
  140551  0 2 0.00  5.60 0.95 0.16
  280551  0 2 0.00  5.60 0.95 0.16
  110651  0 2 0.00  5.60 0.95 0.16
  300452  0 2 0.00  5.60 0.95 0.16
  140552  0 2 0.00  5.60 0.95 0.16
  280552  0 2 0.00  5.60 0.95 0.16
  110652  0 2 0.00  5.60 0.95 0.16
  300453  0 2 0.00  5.60 0.95 0.16
  140553  0 2 0.00  5.60 0.95 0.16
  280553  0 2 0.00  5.60 0.95 0.16
  110653  0 2 0.00  5.60 0.95 0.16
  300454  0 2 0.00  5.60 0.95 0.16
  140554  0 2 0.00  5.60 0.95 0.16
  280554  0 2 0.00  5.60 0.95 0.16
  110654  0 2 0.00  5.60 0.95 0.16
  300455  0 2 0.00  5.60 0.95 0.16
  140555  0 2 0.00  5.60 0.95 0.16
  280555  0 2 0.00  5.60 0.95 0.16
  110655  0 2 0.00  5.60 0.95 0.16
  300456  0 2 0.00  5.60 0.95 0.16
  140556  0 2 0.00  5.60 0.95 0.16
  280556  0 2 0.00  5.60 0.95 0.16
  110656  0 2 0.00  5.60 0.95 0.16
  300457  0 2 0.00  5.60 0.95 0.16
  140557  0 2 0.00  5.60 0.95 0.16
  280557  0 2 0.00  5.60 0.95 0.16
  110657  0 2 0.00  5.60 0.95 0.16
  300458  0 2 0.00  5.60 0.95 0.16
  140558  0 2 0.00  5.60 0.95 0.16
  280558  0 2 0.00  5.60 0.95 0.16
  110658  0 2 0.00  5.60 0.95 0.16
```

300459	0	2	0.00	5.60	0.95	0.16
140559	0	2	0.00	5.60	0.95	0.16
280559	0	2	0.00	5.60	0.95	0.16
110659	0	2	0.00	5.60	0.95	0.16
300460	0	2	0.00	5.60	0.95	0.16
140560	0	2	0.00	5.60	0.95	0.16
280560	0	2	0.00	5.60	0.95	0.16
110660	0	2	0.00	5.60	0.95	0.16
300461	0	2	0.00	5.60	0.95	0.16
140561	0	2	0.00	5.60	0.95	0.16
280561	0	2	0.00	5.60	0.95	0.16
110661	0	2	0.00	5.60	0.95	0.16
300462	0	2	0.00	5.60	0.95	0.16
140562	0	2	0.00	5.60	0.95	0.16
280562	0	2	0.00	5.60	0.95	0.16
110662	0	2	0.00	5.60	0.95	0.16
300463	0	2	0.00	5.60	0.95	0.16
140563	0	2	0.00	5.60	0.95	0.16
280563	0	2	0.00	5.60	0.95	0.16
110663	0	2	0.00	5.60	0.95	0.16
300464	0	2	0.00	5.60	0.95	0.16
140564	0	2	0.00	5.60	0.95	0.16
280564	0	2	0.00	5.60	0.95	0.16
110664	0	2	0.00	5.60	0.95	0.16
300465	0	2	0.00	5.60	0.95	0.16
140565	0	2	0.00	5.60	0.95	0.16
280565	0	2	0.00	5.60	0.95	0.16
110665	0	2	0.00	5.60	0.95	0.16
300466	0	2	0.00	5.60	0.95	0.16
140566	0	2	0.00	5.60	0.95	0.16
280566	0	2	0.00	5.60	0.95	0.16
110666	0	2	0.00	5.60	0.95	0.16
300467	0	2	0.00	5.60	0.95	0.16
140567	0	2	0.00	5.60	0.95	0.16
280567	0	2	0.00	5.60	0.95	0.16
110667	0	2	0.00	5.60	0.95	0.16
300468	0	2	0.00	5.60	0.95	0.16
140568	0	2	0.00	5.60	0.95	0.16
280568	0	2	0.00	5.60	0.95	0.16
110668	0	2	0.00	5.60	0.95	0.16
300469	0	2	0.00	5.60	0.95	0.16
140569	0	2	0.00	5.60	0.95	0.16
280569	0	2	0.00	5.60	0.95	0.16
110669	0	2	0.00	5.60	0.95	0.16
300470	0	2	0.00	5.60	0.95	0.16
140570	0	2	0.00	5.60	0.95	0.16
280570	0	2	0.00	5.60	0.95	0.16
110670	0	2	0.00	5.60	0.95	0.16
300471	0	2	0.00	5.60	0.95	0.16
140571	0	2	0.00	5.60	0.95	0.16
280571	0	2	0.00	5.60	0.95	0.16

110671	0	2	0.00	5.60	0.95	0.16
300472	0	2	0.00	5.60	0.95	0.16
140572	0	2	0.00	5.60	0.95	0.16
280572	0	2	0.00	5.60	0.95	0.16
110672	0	2	0.00	5.60	0.95	0.16
300473	0	2	0.00	5.60	0.95	0.16
140573	0	2	0.00	5.60	0.95	0.16
280573	0	2	0.00	5.60	0.95	0.16
110673	0	2	0.00	5.60	0.95	0.16
300474	0	2	0.00	5.60	0.95	0.16
140574	0	2	0.00	5.60	0.95	0.16
280574	0	2	0.00	5.60	0.95	0.16
110674	0	2	0.00	5.60	0.95	0.16
300475	0	2	0.00	5.60	0.95	0.16
140575	0	2	0.00	5.60	0.95	0.16
280575	0	2	0.00	5.60	0.95	0.16
110675	0	2	0.00	5.60	0.95	0.16
300476	0	2	0.00	5.60	0.95	0.16
140576	0	2	0.00	5.60	0.95	0.16
280576	0	2	0.00	5.60	0.95	0.16
110676	0	2	0.00	5.60	0.95	0.16
300477	0	2	0.00	5.60	0.95	0.16
140577	0	2	0.00	5.60	0.95	0.16
280577	0	2	0.00	5.60	0.95	0.16
110677	0	2	0.00	5.60	0.95	0.16
300478	0	2	0.00	5.60	0.95	0.16
140578	0	2	0.00	5.60	0.95	0.16
280578	0	2	0.00	5.60	0.95	0.16
110678	0	2	0.00	5.60	0.95	0.16
300479	0	2	0.00	5.60	0.95	0.16
140579	0	2	0.00	5.60	0.95	0.16
280579	0	2	0.00	5.60	0.95	0.16
110679	0	2	0.00	5.60	0.95	0.16
300480	0	2	0.00	5.60	0.95	0.16
140580	0	2	0.00	5.60	0.95	0.16
280580	0	2	0.00	5.60	0.95	0.16
110680	0	2	0.00	5.60	0.95	0.16
300481	0	2	0.00	5.60	0.95	0.16
140581	0	2	0.00	5.60	0.95	0.16
280581	0	2	0.00	5.60	0.95	0.16
110681	0	2	0.00	5.60	0.95	0.16
300482	0	2	0.00	5.60	0.95	0.16
140582	0	2	0.00	5.60	0.95	0.16
280582	0	2	0.00	5.60	0.95	0.16
110682	0	2	0.00	5.60	0.95	0.16
300483	0	2	0.00	5.60	0.95	0.16
140583	0	2	0.00	5.60	0.95	0.16
280583	0	2	0.00	5.60	0.95	0.16
110683	0	2	0.00	5.60	0.95	0.16

0. 1

```
    0.00   0.000    0.50
Soil Series: Adamsville sand; Hydrogic Group C
*** Kd for sandy loam = 1.7
  100.00          0   0   0   0   0   0   0   0   0
  00.0    0.00     00.00
       3
       1  10.000   1.440   0.086   0.000   0.000   0.000
          .058    .058     0.000
           0.100   0.086   0.036   0.580     1.7
       2  10.000   1.440   0.086   0.000   0.000   0.000
          .029    .029     0.000
           1.000   0.086   0.036   0.580     1.7
       3  80.000   1.580   0.030   0.000   0.000   0.000
          .029    .029     0.000
           5.000   0.030   0.023   0.116     1.7
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR
   10   1
       6
      11  -----
       1    DAY
    RUNF    TSER   0   0   1.E0
```

Average Application Rate: Florida Citrus, Index Reservoir

```
PRZM3 Input File, flcit.inp (Jan 28 2000)
*** original file source unknown ***
*** Source of crop and soil data unknown ***
*** modified for carbaryl by Laurence Libelo, 6/21/00 ***
Location: Osceola County, FL.; Crop: citrus; MLRA 156A
    0.77    0.15       0   25.00       1       1
       4
    0.10    0.13    1.00   172.8               3   1.00   600.0
       1
       1    0.10  100.00   80.00       3  94  84  89    0.00
100.00
       1       3
0101 21 9 2209
0.10 0.10 0.10
.023 .023 .023
      36
  110548  170748   10848       1
  110549  170749   10849       1
  110550  170750   10850       1
  110551  170751   10851       1
  110552  170752   10852       1
  110553  170753   10853       1
  110554  170754   10854       1
  110555  170755   10855       1
  110556  170756   10856       1
  110557  170757   10857       1
  110558  170758   10858       1
  110559  170759   10859       1
  110560  170760   10860       1
  110561  170761   10861       1
  110562  170762   10862       1
  110563  170763   10863       1
  110564  170764   10864       1
  110565  170765   10865       1
  110566  170766   10866       1
  110567  170767   10867       1
  110568  170768   10868       1
  110569  170769   10869       1
  110570  170770   10870       1
  110571  170771   10871       1
  110572  170772   10872       1
  110573  170773   10873       1
  110574  170774   10874       1
  110575  170775   10875       1
  110576  170776   10876       1
  110577  170777   10877       1
  110578  170778   10878       1
  110579  170779   10879       1
  110580  170780   10880       1
```

```
    110581  170781   10881       1
    110582  170782   10882       1
    110583  170783   10883       1
Application = average -  2 aps @ 3.4 lb A.I./acre
*** Application: 4 aerial appls @ 5 lb a.i./ac/year (5.6 kg/ha)
@95% eff, w/16%drift
       72       1       0       0
CARBARYL on FL Cirtus
    300448  0 2 0.00  3.81 0.95 0.16
    170548  0 2 0.00  3.81 0.95 0.16
    300449  0 2 0.00  3.81 0.95 0.16
    170549  0 2 0.00  3.81 0.95 0.16
    300450  0 2 0.00  3.81 0.95 0.16
    170550  0 2 0.00  3.81 0.95 0.16
    300451  0 2 0.00  3.81 0.95 0.16
    170551  0 2 0.00  3.81 0.95 0.16
    300452  0 2 0.00  3.81 0.95 0.16
    170552  0 2 0.00  3.81 0.95 0.16
    300453  0 2 0.00  3.81 0.95 0.16
    170553  0 2 0.00  3.81 0.95 0.16
    300454  0 2 0.00  3.81 0.95 0.16
    170554  0 2 0.00  3.81 0.95 0.16
    300455  0 2 0.00  3.81 0.95 0.16
    170555  0 2 0.00  3.81 0.95 0.16
    300456  0 2 0.00  3.81 0.95 0.16
    170556  0 2 0.00  3.81 0.95 0.16
    300457  0 2 0.00  3.81 0.95 0.16
    170557  0 2 0.00  3.81 0.95 0.16
    300458  0 2 0.00  3.81 0.95 0.16
    170558  0 2 0.00  3.81 0.95 0.16
    300459  0 2 0.00  3.81 0.95 0.16
    170559  0 2 0.00  3.81 0.95 0.16
    300460  0 2 0.00  3.81 0.95 0.16
    170560  0 2 0.00  3.81 0.95 0.16
    300461  0 2 0.00  3.81 0.95 0.16
    170561  0 2 0.00  3.81 0.95 0.16
    300462  0 2 0.00  3.81 0.95 0.16
    170562  0 2 0.00  3.81 0.95 0.16
    300463  0 2 0.00  3.81 0.95 0.16
    170563  0 2 0.00  3.81 0.95 0.16
    300464  0 2 0.00  3.81 0.95 0.16
    170564  0 2 0.00  3.81 0.95 0.16
    300465  0 2 0.00  3.81 0.95 0.16
    170565  0 2 0.00  3.81 0.95 0.16
    300466  0 2 0.00  3.81 0.95 0.16
    170566  0 2 0.00  3.81 0.95 0.16
    300467  0 2 0.00  3.81 0.95 0.16
    170567  0 2 0.00  3.81 0.95 0.16
    300468  0 2 0.00  3.81 0.95 0.16
    170568  0 2 0.00  3.81 0.95 0.16
    300469  0 2 0.00  3.81 0.95 0.16
```

```
  170569  0 2 0.00  3.81 0.95 0.16
  300470  0 2 0.00  3.81 0.95 0.16
  170570  0 2 0.00  3.81 0.95 0.16
  300471  0 2 0.00  3.81 0.95 0.16
  170571  0 2 0.00  3.81 0.95 0.16
  300472  0 2 0.00  3.81 0.95 0.16
  170572  0 2 0.00  3.81 0.95 0.16
  300473  0 2 0.00  3.81 0.95 0.16
  170573  0 2 0.00  3.81 0.95 0.16
  300474  0 2 0.00  3.81 0.95 0.16
  170574  0 2 0.00  3.81 0.95 0.16
  300475  0 2 0.00  3.81 0.95 0.16
  170575  0 2 0.00  3.81 0.95 0.16
  300476  0 2 0.00  3.81 0.95 0.16
  170576  0 2 0.00  3.81 0.95 0.16
  300477  0 2 0.00  3.81 0.95 0.16
  170577  0 2 0.00  3.81 0.95 0.16
  300478  0 2 0.00  3.81 0.95 0.16
  170578  0 2 0.00  3.81 0.95 0.16
  300479  0 2 0.00  3.81 0.95 0.16
  170579  0 2 0.00  3.81 0.95 0.16
  300480  0 2 0.00  3.81 0.95 0.16
  170580  0 2 0.00  3.81 0.95 0.16
  300481  0 2 0.00  3.81 0.95 0.16
  170581  0 2 0.00  3.81 0.95 0.16
  300482  0 2 0.00  3.81 0.95 0.16
  170582  0 2 0.00  3.81 0.95 0.16
  300483  0 2 0.00  3.81 0.95 0.16
  170583  0 2 0.00  3.81 0.95 0.16

      0.        1
    0.00   0.000    0.50
Soil Series: Adamsville sand; Hydrogic Group C
*** Kd for sandy loam = 1.7
  100.00           0   0   0   0   0   0   0   0   0
  00.0    0.00     00.00
       3
       1  10.000   1.440   0.086   0.000   0.000   0.000
          .058    .058     0.000
           0.100   0.086   0.036   0.580     1.7
       2  10.000   1.440   0.086   0.000   0.000   0.000
          .029    .029     0.000
           1.000   0.086   0.036   0.580     1.7
       3  80.000   1.580   0.030   0.000   0.000   0.000
          .029    .029     0.000
           5.000   0.030   0.023   0.116     1.7
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR
   10   1
       6
      11  -----
```

```
   1     DAY
RUNF     TSER   0   0   1.E0
```

Maximum Reported Application Rate: Florida Citrus, Index Reservoir

```
PRZM3 Input File, flcit.inp (Jan 28 2000)
*** original file source unknown ***
*** Source of crop and soil data unknown ***
*** modified for carbaryl by Laurence Libelo, 6/21/00 ***
Location: Osceola County, FL.; Crop: citrus; MLRA 156A
    0.77    0.15       0   25.00       1       1
       4
    0.10    0.13    1.00   172.8               3   1.00   600.0
       1
       1    0.10  100.00   80.00       3  94  84  89    0.00
100.00
       1       3
0101 21 9 2209
0.10 0.10 0.10
.023 .023 .023
      36
  110548  170748   10848       1
  110549  170749   10849       1
  110550  170750   10850       1
  110551  170751   10851       1
  110552  170752   10852       1
  110553  170753   10853       1
  110554  170754   10854       1
  110555  170755   10855       1
  110556  170756   10856       1
  110557  170757   10857       1
  110558  170758   10858       1
  110559  170759   10859       1
  110560  170760   10860       1
  110561  170761   10861       1
  110562  170762   10862       1
  110563  170763   10863       1
  110564  170764   10864       1
  110565  170765   10865       1
  110566  170766   10866       1
  110567  170767   10867       1
  110568  170768   10868       1
  110569  170769   10869       1
  110570  170770   10870       1
  110571  170771   10871       1
  110572  170772   10872       1
  110573  170773   10873       1
  110574  170774   10874       1
  110575  170775   10875       1
  110576  170776   10876       1
  110577  170777   10877       1
  110578  170778   10878       1
  110579  170779   10879       1
```

```
  110580  170780   10880       1
  110581  170781   10881       1
  110582  170782   10882       1
  110583  170783   10883       1
Application = maximum reported 3 aps @ 4.26 lb A.I./acre
*** Application: 4 aerial appls @ 5 lb a.i./ac/year (5.6 kg/ha)
@95% eff, w/16%drift
     108       1       0       0
CARBARYL on FL Cirtus
  300448  0 2 0.00  4.77 0.95 0.16
  140548  0 2 0.00  4.77 0.95 0.16
  280548  0 2 0.00  4.77 0.95 0.16
  300449  0 2 0.00  4.77 0.95 0.16
  140549  0 2 0.00  4.77 0.95 0.16
  280549  0 2 0.00  4.77 0.95 0.16
  300450  0 2 0.00  4.77 0.95 0.16
  140550  0 2 0.00  4.77 0.95 0.16
  280550  0 2 0.00  4.77 0.95 0.16
  300451  0 2 0.00  4.77 0.95 0.16
  140551  0 2 0.00  4.77 0.95 0.16
  280551  0 2 0.00  4.77 0.95 0.16
  300452  0 2 0.00  4.77 0.95 0.16
  140552  0 2 0.00  4.77 0.95 0.16
  280552  0 2 0.00  4.77 0.95 0.16
  300453  0 2 0.00  4.77 0.95 0.16
  140553  0 2 0.00  4.77 0.95 0.16
  280553  0 2 0.00  4.77 0.95 0.16
  300454  0 2 0.00  4.77 0.95 0.16
  140554  0 2 0.00  4.77 0.95 0.16
  280554  0 2 0.00  4.77 0.95 0.16
  300455  0 2 0.00  4.77 0.95 0.16
  140555  0 2 0.00  4.77 0.95 0.16
  280555  0 2 0.00  4.77 0.95 0.16
  300456  0 2 0.00  4.77 0.95 0.16
  140556  0 2 0.00  4.77 0.95 0.16
  280556  0 2 0.00  4.77 0.95 0.16
  300457  0 2 0.00  4.77 0.95 0.16
  140557  0 2 0.00  4.77 0.95 0.16
  280557  0 2 0.00  4.77 0.95 0.16
  300458  0 2 0.00  4.77 0.95 0.16
  140558  0 2 0.00  4.77 0.95 0.16
  280558  0 2 0.00  4.77 0.95 0.16
  300459  0 2 0.00  4.77 0.95 0.16
  140559  0 2 0.00  4.77 0.95 0.16
  280559  0 2 0.00  4.77 0.95 0.16
  300460  0 2 0.00  4.77 0.95 0.16
  140560  0 2 0.00  4.77 0.95 0.16
  280560  0 2 0.00  4.77 0.95 0.16
  300461  0 2 0.00  4.77 0.95 0.16
  140561  0 2 0.00  4.77 0.95 0.16
  280561  0 2 0.00  4.77 0.95 0.16
```

300462	0	2	0.00	4.77	0.95	0.16
140562	0	2	0.00	4.77	0.95	0.16
280562	0	2	0.00	4.77	0.95	0.16
300463	0	2	0.00	4.77	0.95	0.16
140563	0	2	0.00	4.77	0.95	0.16
280563	0	2	0.00	4.77	0.95	0.16
300464	0	2	0.00	4.77	0.95	0.16
140564	0	2	0.00	4.77	0.95	0.16
280564	0	2	0.00	4.77	0.95	0.16
300465	0	2	0.00	4.77	0.95	0.16
140565	0	2	0.00	4.77	0.95	0.16
280565	0	2	0.00	4.77	0.95	0.16
300466	0	2	0.00	4.77	0.95	0.16
140566	0	2	0.00	4.77	0.95	0.16
280566	0	2	0.00	4.77	0.95	0.16
300467	0	2	0.00	4.77	0.95	0.16
140567	0	2	0.00	4.77	0.95	0.16
280567	0	2	0.00	4.77	0.95	0.16
300468	0	2	0.00	4.77	0.95	0.16
140568	0	2	0.00	4.77	0.95	0.16
280568	0	2	0.00	4.77	0.95	0.16
300469	0	2	0.00	4.77	0.95	0.16
140569	0	2	0.00	4.77	0.95	0.16
280569	0	2	0.00	4.77	0.95	0.16
300470	0	2	0.00	4.77	0.95	0.16
140570	0	2	0.00	4.77	0.95	0.16
280570	0	2	0.00	4.77	0.95	0.16
300471	0	2	0.00	4.77	0.95	0.16
140571	0	2	0.00	4.77	0.95	0.16
280571	0	2	0.00	4.77	0.95	0.16
300472	0	2	0.00	4.77	0.95	0.16
140572	0	2	0.00	4.77	0.95	0.16
280572	0	2	0.00	4.77	0.95	0.16
300473	0	2	0.00	4.77	0.95	0.16
140573	0	2	0.00	4.77	0.95	0.16
280573	0	2	0.00	4.77	0.95	0.16
300474	0	2	0.00	4.77	0.95	0.16
140574	0	2	0.00	4.77	0.95	0.16
280574	0	2	0.00	4.77	0.95	0.16
300475	0	2	0.00	4.77	0.95	0.16
140575	0	2	0.00	4.77	0.95	0.16
280575	0	2	0.00	4.77	0.95	0.16
300476	0	2	0.00	4.77	0.95	0.16
140576	0	2	0.00	4.77	0.95	0.16
280576	0	2	0.00	4.77	0.95	0.16
300477	0	2	0.00	4.77	0.95	0.16
140577	0	2	0.00	4.77	0.95	0.16
280577	0	2	0.00	4.77	0.95	0.16
300478	0	2	0.00	4.77	0.95	0.16
140578	0	2	0.00	4.77	0.95	0.16
280578	0	2	0.00	4.77	0.95	0.16

```
  300479  0 2 0.00  4.77 0.95 0.16
  140579  0 2 0.00  4.77 0.95 0.16
  280579  0 2 0.00  4.77 0.95 0.16
  300480  0 2 0.00  4.77 0.95 0.16
  140580  0 2 0.00  4.77 0.95 0.16
  280580  0 2 0.00  4.77 0.95 0.16
  300481  0 2 0.00  4.77 0.95 0.16
  140581  0 2 0.00  4.77 0.95 0.16
  280581  0 2 0.00  4.77 0.95 0.16
  300482  0 2 0.00  4.77 0.95 0.16
  140582  0 2 0.00  4.77 0.95 0.16
  280582  0 2 0.00  4.77 0.95 0.16
  300483  0 2 0.00  4.77 0.95 0.16
  140583  0 2 0.00  4.77 0.95 0.16
  280583  0 2 0.00  4.77 0.95 0.16

      0.       1
    0.00   0.000    0.50
Soil Series: Adamsville sand; Hydrogic Group C
*** Kd for sandy loam = 1.7
  100.00           0   0   0   0   0   0   0   0   0
  00.0    0.00     00.00
       3
       1  10.000   1.440   0.086   0.000   0.000   0.000
          .058    .058     0.000
           0.100   0.086   0.036   0.580     1.7
       2  10.000   1.440   0.086   0.000   0.000   0.000
          .029    .029     0.000
           1.000   0.086   0.036   0.580     1.7
       3  80.000   1.580   0.030   0.000   0.000   0.000
          .029    .029     0.000
           5.000   0.030   0.023   0.116     1.7
       0
    WATR     YEAR      10    PEST     YEAR      10    CONC     YEAR
   10   1
       6
      11  -----
       1    DAY
    RUNF     TSER   0   0   1.E0
```

APPENDIX A2: Results of Scigrow Run for Carbaryl

RUN No. 1 FOR Carbaryl INPUT VALUES

APPL (#/AC) RATE	APPL. NO.	URATE (#/AC/YR)	SOIL KOC	SOIL AEROBIC METABOLISM (DAYS)
5.000	4	20.000	211.0	12.0

GROUND-WATER SCREENING CONCENTRATIONS IN PPB

.829154

```
A=    7.000  B=  216.000  C=     .845  D=    2.334  RILP=    1.408
F=   -1.382  G=     .041  URATE=   20.000  GWSC=       .829154
```

Appendix B: Ecological Risk Assessment

ECOLOGICAL RISK ASSESSMENT

Risk characterization integrates the results of exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects, using for this purpose the risk quotient (RQ) method. RQs are calculated by dividing estimated environmental concentrations (EECs) of the pesticide by acute and chronic toxicity values. Although EECs are primarily based on the maximum label application rates for that pesticide, EECs based on QUA average and maximum reported (Doane data) use rates were also considered in this assessment. The 74 carbaryl registered uses and application specifications (methods, maximum label use rates, number of applications, and interval between applications) used in the risk assessment for terrestrial organisms are summarized in Table 1.

RQs are compared to levels of concern (LOC) criteria used by OPP for determining potential risk to nontarget organisms and the subsequent need for possible regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. Levels of concern currently address the following risk presumption categories: (1) acute -- potential for acute risk; regulatory action may be warranted in addition to restricted use classification, (2) acute restricted use -- potential for acute risk, but may be mitigated through restricted use classification, (3) acute endangered species - potential for acute risk to endangered species; regulatory action may be warranted, and (4) chronic risk - the potential for chronic risk is high, and regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to birds or mammals. Risk presumptions and the corresponding risk quotients and levels of concern are summarized in Table 2.

In addition, the Agency considers any incident data that is submitted concerning adverse effects on nontarget species.

Table 1. Uses, application rates, and application intervals used in the risk assessment for carbaryl[1]

Uses	Non-granular Formulations				Granular/ Bait
Use/Crop	Appl Rate (lb ai/A)	No. Appl	Interval (days)	Max lb/ year	Rate (lb ai/A)
Asparagus	2	5	3	10	2
Broccoli, Brussels sprouts, cauliflower, collards, cabbage, mustard greens, lettuce, parsley, spinach, celery, Swiss chard, (beets, carrots, potato, radish, horseradish, parsnip, rutabaga, salsify	2	3	7	6	2
Corn (field, pop)	2	4	14	8	-----
Sorghum	2	3	7	6	-----
Rice (tadpole shrimp)	1.5	2	7	4	-----
Corn (sweet)	2	8	3	16	2
Flax, millet, wheat, pasture, grasses, noncropland,	1.5	2	14	3	-----
Cucurbits (melons, cucumbers, squash, pumpkin)	1	6	7	6	-----
Alfalfa, clover	1.5	8	30	12	-----
Rangeland	1	1	----	1	-----
Solanaceous crops (tomato, pepper, eggplant), tobacco	2	4	7	8	2
Legumes (beans, peas, lentils, cowpeas, soybean)	1.5	4	7	6	-----
Peanuts, sweet potatoes	2	4	7	8	-----
Sugar beets	1.5	2	14	4	1.5
Small fruits & berries (grape, blueberry, caneberry, cranberry, strawberry)	2	5	7	10	-----
Strawberry	----	----	----	-----	2
Sunflower	1.5	2	7	3	-----
Citrus (orange, lemon, grapefruit)	5, 16	4	14	20	-----
Olives	7.5	2	14	15	-----
Pome fruits (apple, pear)	3	5	14	15	-----
Stone fruits (peach, apricot, cherry, nectarine, plum/prune)	4	3	14	14	-----
Tree nuts (almond, chestnut, filbert, pecan, pistachios, walnut)	5	3	7	15	-----
Forested areas (non-urban)	1	2	7	2	-----
Trees and ornamentals	1	6	7	6	9.1
Turfgrass	8	2	7	16	9.1
Ticks	-----		-----		9.1
Oyster beds	1		-----	10	

[1] Aerial and ground application methods for all uses

Table 2. Risk presumptions for terrestrial animals

Risk Presumption	Risk Quotient (RQ)	Level of Concern (LOC)
Birds		
Acute Risk	EEC[1]/LC_{50} or LD_{50}/sqft[2] or LD_{50}/day[3]	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Wild Mammals		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items

[2] $\frac{mg/ft^2}{LD_{50} * \text{wt. of bird}}$ [3] $\frac{\text{mg of toxicant consumed/day}}{LD_{50} * \text{wt. of bird}}$

Risk presumptions for aquatic animals

Risk Presumption	RQ	LOC
Acute Risk	EEC[1]/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1

[1] EEC = (ppm or ppb) in water

Risk presumptions for plants

Risk Presumption	RQ	LOC
Plant Inhabiting Terrestrial and Semi-Aquatic Areas		
Acute Risk	EEC[1]/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1
Aquatic Plants		
Acute Risk	EEC[2]/EC_{50}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1

[1] EEC = lbs a.i./A
[2] EEC = (ppb or ppm) in water

Exposure and Risk to Nontarget Terrestrial Animals

For nongranular pesticide applications (*e.g.*, liquid, dust), the estimated environmental concentrations (EECs) on food items following product application are compared to LC_{50} values to assess risk. The predicted 0-day maximum and mean residues of a pesticide that may be expected to occur on selected avian or mammalian food items immediately following a direct single application at 1 lb a.i./A are tabulated in Table 3.

Table 3. Estimated environmental concentrations (EECs) on avian and mammalian food items (ppm) following a single application at 1 lb a.i./A)

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb a.i./a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

The following toxicity endpoints are used in the risk assessment of carbaryl:

Avian acute oral LD_{50}	rock dove = 1000 mg/kg
Avian subacute dietary LC_{50}	bobwhite quail = >5000 ppm
Avian chronic (reproduction) NOAEC	mallard duck = 300 ppm
Mammalian acute oral LD50	rat = 301 mg/kg
Mammalian chronic (reproduction) NOAEC	rat = 80 ppm
Freshwater fish acute LC_{50}	salmon = 0.25 ppm
Freshwater fish acute (TEP) LC_{50}	trout = 1.2 ppm
Freshwater fish chronic NOAEC	minnow = 0.21 ppm
Freshwater invertebrate acute LC_{50}	stonefly = 1.7 ppb
Freshwater invertebrate chronic NOAEC	waterflea = 1.5 ppb
Estuarine/marine fish acute LC_{50}	minnow = 2.6 ppm
Estuarine/marine mollusc acute EC_{50}	oyster = 2.7 ppm
Estuarine/marine shrimp EC_{50}	mysid = 5.7 ppb
Estuarine/marine fish chronic NOAEC	no data
Estuarine/marine aquatic invertebrate chronic NOAEC	no data

Avian Acute and Chronic Risk

Risk from Exposure to Nongranular Products

Since the avian LC_{50} is greater than 5,000 ppm (Appendix C), with zero mortality observed at this concentration for the four avian species tested, carbaryl is classified as practically nontoxic to birds, and the avian LC_{50} value for carbaryl can be considered a NOAEC value. Therefore, for the avian risk assessment, acute RQs for nongranular carbaryl are compared to an acute risk LOC of 1, rather than to the established avian risk LOCs shown in Table 2. On this basis, no avian acute risk LOCs are exceeded for nongranular carbaryl at maximum label application rates (Table 4).

Based on an avian NOAEC of 300 ppm and maximum label application rates, the avian chronic risk LOC is exceeded for most nongranular uses (Table 4). For birds feeding on short grasses, the avian chronic risk LOC is exceeded for all uses, except rangeland. For tall grass feeders, the avian chronic LOC is exceeded for all uses, except sugar beets, wheat, millet, flax, pasture, grasses, noncropland, rangeland, and non-urban forested areas. For birds feeding on broadleaf/forage plants and small insects the avian chronic LOC is exceeded for all uses except for rangeland and non-urban forested areas. The chronic LOC for birds feeding on fruits, pods, seeds, and large insects is not exceeded for any of the carbaryl uses.

In addition to maximum label use rates, avian acute and chronic RQs were also calculated for nongranular carbaryl using QUA average use rates (Table 5a) for 70 use sites, as well as maximum reported (Doane data) use rates for 42 use sites (Table 5b). The acute risk LOCs are not exceeded for any nongranular carbaryl use at less than maximum label use rates. When RQs are based on average application rates, the chronic risk LOC is exceeded for 39 of 70 uses. For RQs based on maximum reported use rates, the chronic risk LOC is met or exceeded for 34 of 42 uses (Table 5b).

Table 4. Avian acute and chronic RQs for multiple applications of nongranular carbaryl (broadcast) based on a bobwhite quail LC_{50} of >5000 ppm, a mallard duck NOAEC of 300 ppm, and maximum label application rates.

Uses	Appl. Rate No. Appl. Interval	Food Items	Maximum EEC[1] (ppm)	LC_{50} (ppm)	NOAEC (ppm)	Acute RQ (EEC/ LC_{50})	Chron. RQ (EEC/ NOAEC)
Citrus (orange, lemon, grapefruit)	5 lb ai/A	Short grass	3320.98	>5000	300	<0.66	11.07
	4 appl	Tall grass	1522.12			<0.30	5.07
	14 days	Broadleaf plants, sm. ins.	1868.05			<0.37	6.23
		Fruit, seeds, lg. insects	207.56			<0.04	0.69
Citrus (California)	16 lb ai/A	Short grass	3840.00	>5000	300	<0.77	12.80
	1 appl	Tall grass	1760.00			<0.35	5.87
		Broadleaf plants, sm. ins.	2160.00			<0.43	7.20
		Fruit, seeds, lg. insects	240.00			<0.05	0.80
Olives	7.5 lb ai/A	Short grass	3164.15	>5000	300	<0.63	10.55
	2 appl	Tall grass	1450.23			<0.29	4.83
	14 days	Broadleaf plants, sm. ins.	1779.83			<0.36	5.93
		Fruit, seeds, lg. insects	197.76			<0.04	0.66
Pome fruits (apple, pear)	3 lb ai/A	Short grass	2230.10	>5000	300	<0.45	7.43
	5 appl	Tall grass	1022.13			<0.20	3.41
	14 days	Broadleaf plants, sm. ins.	1254.43			<0.25	4.18
		Fruit, seeds, lg. insects	139.38			<0.03	0.46
Stone fruits (peaches, apricot, cherry, nectarine, plum/prune)	4 lb ai/A	Short grass	2238.92	>5000	300	<0.45	7.46
	3 appl	Tall grass	1026.17			<0.21	3.42
	14 days	Broadleaf plants, sm. ins.	1259.39			<0.25	4.20
		Fruit, seeds, lg. insects	139.93			<0.03	0.47
Tree nuts (almond, chestnut, filbert, pecan, pistachios, walnut)	5 lb ai/A	Short grass	3154.09	>5000	300	<0.63	10.51
	3 appl	Tall grass	1445.62			<0.29	4.82
	7 days	Broadleaf plants, sm. ins.	1774.18			<0.35	5.91
		Fruit, seeds, lg. insects	197.13			<0.04	0.66
Corn (field, pop)	2 lb ai/A	Short grass	1328.39	>5000	300	<0.27	4.43
	4 appl	Tall grass	608.85			<0.12	2.03
	14 days	Broadleaf plants, sm. ins.	747.22			<0.15	2.49
		Fruit, seeds, lg. insects	83.02			<0.02	0.28
Corn (sweet)	2 lb ai/A	Short grass	3148.03	>5000	300	<0.63	10.49
	8 appl	Tall grass	1442.85			<0.29	4.81
	3 days	Broadleaf plants, sm. ins.	1770.77			<0.35	5.90
		Fruit, seeds, lg. insects	196.75			<0.04	0.66
Rice, sunflower	1.5 lb ai/A	Short grass	673.40	>5000	300	<0.13	2.24
	2 appl	Tall grass	308.64			<0.06	1.03
	7 days	Broadleaf plants, sm. ins.	378.79			<0.08	1.26
		Fruit, seeds, lg. insects	42.09			<0.01	0.14
Sugar beets, wheat, millet, flax, pasture, grasses, noncropland	1.5 lb ai/A	Short grass	632.83	>5000	300	<0.13	2.11
	2 appl	Tall grass	290.05			<0.06	0.97
	14 days	Broadleaf plants, sm. ins.	355.97			<0.07	1.19
		Fruit, seeds, lg. insects	39.55			<0.01	0.13
Asparagus	2 lb ai/A	Short grass	2138.64	>5000	300	<0.43	7.13
	5 appl	Tall grass	980.21			<0.20	3.27
	3 days	Broadleaf plants, sm. ins.	1202.99			<0.24	4.01
		Fruit, seeds, lg. insects	133.67			<0.03	0.45

Broccoli, Brussels sprouts, cabbage, cauliflower, collards, mustard greens, celery, lettuce, parsley, spinach, beets, potato, carrot, horseradish, parsnip, rutabaga, salsify, sorghum	2 lb ai/A	Short grass	1261.64	>5000	300	<0.25	4.21
	3 appl	Tall grass	578.25			<0.12	1.93
	7 days	Broadleaf plants, sm. ins.	709.67			<0.14	2.37
		Fruit, seeds, lg. insects	78.85			<0.02	0.26

Table 4. Avian acute and chronic RQs for multiple applications of nongranular carbaryl (broadcast) based on a bobwhite quail LC_{50} of >5000 ppm, a mallard duck NOAEC of 300 ppm, and maximum label application rates.

Uses	Appl. Rate No. Appl. Interval	Food Items	Maximum EEC[1] (ppm)	LC_{50} (ppm)	NOAEC (ppm)	Acute RQ (EEC/ LC_{50})	Chron. RQ (EEC/ NOAEC)
Cucurbits (cucumbers, melons, squash, pumpkin), trees and ornamentals	1 lb ai/A	Short grass	1047.00	>5000	300	<0.21	3.49
	6 appl	Tall grass	479.88			<0.10	1.60
	7 days	Broadleaf plants, sm. ins.	588.94			<0.12	1.96
		Fruit, seeds, lg. insects	65.44			<0.01	0.22
Solanaceous (tomato, pepper, eggplant), peanuts, tobacco, sweet potato	2 lb ai/A	Short grass	1578.32	>5000	300	<0.32	5.26
	4 appl	Tall grass	723.40			<0.14	2.41
	7 days	Broadleaf plants, sm. ins.	887.80			<0.18	2.96
		Fruit, seeds, lg. insects	98.64			<0.02	0.33
Legumes (beans, peas, lentils, cowpeas, soybeans)	1.5 lb ai/A	Short grass	1183.74	>5000	300	<0.24	3.95
	4 appl	Tall grass	542.55			<0.11	1.81
	7 days	Broadleaf plants, sm. ins.	665.85			<0.13	2.22
		Fruit, seeds, lg. insects	73.98			<0.01	0.25
Small fruits & berries (grapes, blueberry, caneberry, cranberry, strawberry)	2 lb ai/A	Short grass	1854.01	>5000	300	<0.37	6.18
	5 appl	Tall grass	849.75			<0.17	2.83
	7 days	Broadleaf plants, sm. ins.	1042.88			<0.21	3.48
		Fruit, seeds, lg. insects	115.88			<0.02	0.39
Alfalfa, clover	1.5 lb ai/A	Short grass	796.72	>5000	300	<0.16	2.66
	8 appl	Tall grass	365.16			<0.07	1.22
	30 days	Broadleaf plants, sm. ins.	448.15			<0.09	1.49
		Fruit, seeds, lg. insects	49.79			<0.01	0.17
Rangeland	1 lb ai/A	Short grass	240.00	>5000	300	<0.05	0.80
	1 appl	Tall grass	110.00			<0.02	0.37
		Broadleaf plants, sm. ins.	135.00			<0.03	0.45
		Fruit, seeds, lg. insects	15.00			<0.00	0.05
Forested areas (non-urban)	1 lb ai/A	Short grass	448.93	>5000	300	<0.09	1.5
	2 appl	Tall grass	205.76			<0.04	0.69
	7 days	Broadleaf plants, sm. ins.	252.52			<0.05	0.84
		Fruit, seeds, lg. insects	28.06			<0.01	0.09
Turfgrass	8 lb ai/A	Short grass	3591.46	5000	300	<0.72	11.97
	2 appl	Tall grass	1646.08			<0.33	5.49
	7 days	Broadleaf plants, sm. ins.	2020.19			<0.40	6.73
		Fruit, seeds, lg. insects	224.47			<0.04	0.75

[1] Predicted maximum residues are for a 1 lb a.i./a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Table 5a. Avian acute and chronic risk quotients[1] for multiple applications of nongranular carbaryl based on a bobwhite quail LC_{50} of >5000 ppm and, a mallard duck NOAEC of 300 ppm, and QUA average application rates for 70 uses					
Use site (Appl. Rate [lb ai/A], No. Applications, Interval)	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)	Use Site	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)
Alfalfa (1.1, 1)	<0.05	0.88	Nectarines (3.8, 1)	<0.18	3.04
Almonds (2.1, 1)	<0.10	1.68	Okra (1.9, 1)	<0.09	1.52
Apples (1.2, 1)	<0.06	0.96	Olives (5.3, 1)	<0.25	4.24
Asparagus (0.9, 1)	<0.04	0.72	Oranges (3.4, 1)	<0.16	2.72
Beans, Dry (0.5, 1)	<0.02	0.40	Pasture (0.9, 1)	<0.04	0.72
Beans, Lima, Fresh (0.9, 1)	<0.04	0.72	Peaches (1.0, 3, 7)	<0.13	2.10
Beans, Snap, Fresh (0.9, 2, 7)	<0.08	1.35	Peanuts (0.8, 1)	<0.04	0.64
Beans, Snap, Processed (0.7, 2, 7)	<0.06	1.05	Pears (1.0, 1,2	<0.08	1.41
Beets (0.5, 1)	<0.02	0.40	Pears, Dry (1.0, 1)	<0.05	0.80
Blackberries (1.7, 1)	<0.08	1.36	Peas, Green (1.5, 1)	<0.07	1.20
Blueberries (1.7, 1)	<0.08	1.36	Pecans (1.4, 2)	<0.13	2.10
Broccoli (0.8, 1)	<0.04	0.64	Peppers, Bell (0.9, 2)	<0.08	1.35
Brussels Sprouts (0.9, 1)	<0.04	0.72	Peppers, Sweet (1.3, 1)	<0.06	1.04
Chinese Cabbage (0.2, 1)	<0.01	0.16	Pistachios (3.6, 1)	<0.17	2.88
Fresh Cabbage (1.0, 2, 7)	<0.09	1.50	Plums (3.8, 1)	<0.18	3.04
Cantaloupes (0.8, 1)	<0.04	0.64	Potatoes (0.8, 2)	<0.07	1.20
Carrots (0.9, 2, 7)	<0.08	1.35	Pumpkins (2.0, 2)	<0.18	2.99
Cauliflower (1.1, 1)	<0.05	0.88	Raspberries (2.8, 1)	<0.13	2.24
Celery (1.0, 2, 7)	<0.09	1.50	Rice (1.1, 1)	<0.05	0.88
Cherries (1.9, 1)	<0.09	1.52	Sorghum (1.1, 1)	<0.05	0.88
Citrus, other (1.8, 2, 14)	<0.15	2.53	Soybeans (0.9, 1)	<0.04	0.72
Corn, Field (1.0, 1)	<0.05	0.80	Squash (1.4, 1)	<0.07	1.12
Cranberries (2.0, 1)	<0.10	1.60	Strawberries (1.4, 2)	<0.13	2.10
Cucumbers (1.1, 1)	<0.05	0.88	Sugar Beets (1.3, 1)	<0.06	1.04
Cucumbers, Processed (0.6, 2, 7)	<0.05	0.90	Sunflower (0.7, 1)	<0.02	0.32
Eggplant (1.0, 2, 7)	<0.09	1.50	Sweet Corn, Fresh (1.3, 3, 3)	<0.18	2.94
Flax (1.1, 1)	<0.05	0.88	Sweet Potatoes (1.6, 1)	<0.08	1.28
Grapefruit (1.4, 2, 14)	<0.12	1.97	Tobacco (1.1, 2,7)	<0.09	1.50
Grapes (1.4, 2, 7)	<0.13	2.10	Tomatoes, Fresh (0.7, 3, 7)	<0.09	1.47
Hay (0.8, 1)	<0.04	0.64	Tomatoes, Processed (1.2, 1)	<0.06	0.96
Hazelnuts (2.5, 1)	<0.12	2.00	Walnuts (1.9, 1)	<0.09	1.52
Lemons (2.7, 1)	<0.13	2.16	Watermelons (0.5, 1)	<0.02	0.40
Lettuce (1.1, 1)	<0.05	0.88	Wheat, Spring (0.6, 1)	<0.03	0.48
Lots/Farmsteads (0.4, 2, 14)	<0.04	0.75	Wheat, Winter (0.8, 1)	<0.04	0.64
Melons (0.7, 1)	<0.03	0.56	Woodland (0.7, 1)	<0.02	0.32

[1]Only the highest RQs -- i.e. those based on short grass EECs -- are included in this table.

Table 5b. Avian highest acute and chronic risk quotients[1] for multiple applications of nongranular carbaryl based on a bobwhite quail LC_{50} of >5000 ppm and, a mallard duck NOAEC of 300 ppm, and maximum reported use rates (Doane data) for 42 use sites

Use site [appl.rate (lb ai/A), No. appl]	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)	Use Site [appl.rate (lb ai/A) No. appl]	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)
Alfalfa (1.5, 1)	<0.07	1.2	Peaches (5,1)	<0.24	4.0
Almonds (4, 1)	<0.19	3.2	Peanuts (2, 1)	<0.10	1.6
Apples (3.2, 1)	<0.15	2.6	Pears (2, 1)	<0.10	1.6
Apricots (4, 1)	<0.19	3.2	Pecans (3, 2, 7)	<0.27	4.5
Asparagus (4, 1)	<0.19	3.2	Peppers (2, 1)	<0.10	1.6
Beans, Lima, (1.3,1)	<0.06	1.0	Pistachios (5, 1)	<0.24	4.0
Beans, snap (1.6,1)	<0.08	1.3	Plums (4, 1)	<0.19	3.2
Cabbage (2,1)	<0.10	1.6	Potatoes (1.5, 1)	<0.07	1.2
Canola (0.5, 1)	<0.02	0.4	Pumpkins (1.5, 1)	<0.07	1.2
Cantaloupe (1.2, 1)	<0.06	1.0	Rice (1.3, 1)	<0.06	1.0
Carrots (0.8, 1)	<0.04	0.6	Sorghum (0.5, 1)	<0.02	0.4
Cauliflower (1, 1)	<0.05	0.8	Squash (1.2, 1)	<0.06	1.0
Celery (2, 1)	<0.10	1.6	Sugar Beets (1.2, 1)	<0.06	1.0
Cherries (5, 1)	<0.24	4.0	Sunflower (1, 1)	<0.05	0.8
Corn, Field (1.5, 2, 14)	<0.13	2.1	Strawberries (2,1)	<0.10	1.6
Cucumbers (1, 1)	<0.05	0.8	Sweet Corn (1.5, 2, 3)	<0.14	2.3
Grapefruit (12.8, 1)	<0.61	10.2	Tobacco (2, 1)	<0.10	1.6
Grapes (2.5,1)	<0.12	2.0	Tomatoes (2,1)	<0.10	1.6
Lemons (8,1)	<0.38	6.4	Walnuts (4, 1)	<0.19	3.2
Lettuce (1, 1)	<0.05	0.8	Watermelons (2, 1)	<0.10	1.6
Oranges (15, 1)	<0.72	12.0	Wheat (1,1)	<0.05	0.8

[1]Only the highest RQs -- i.e. those based on short grass EECs -- are included in this table.

Risk from Exposure to Granular Products

Birds may be exposed to granular pesticides by ingesting granules when foraging for food or grit. Birds may also be exposed by other routes, such as by walking on exposed granules or by drinking water contaminated with granules. The number of lethal doses (LD_{50}) that are available within one square foot immediately after application (LD_{50}/ft2) is used as the risk quotient for granular/bait products. Risk quotients are calculated for birds in three separate weight classes: 1000 g (e.g. waterfowl), 180 g (e.g. upland gamebirds), and 20 g (e.g., songbirds).

Based on a rock dove LD_{50} of 1,000 mg/kg and a mallard LD_{50} greater than 2,000 mg/kg, technical carbaryl can be classified as slightly to practically nontoxic to birds on an acute basis. LD_{50} values for carbaryl as low as 16.2 mg/kg and 56.2 mg/kg have been reported for the starling and the red-winged blackbird, respectively (Schafer et al., 1983). Although these data are based on simple screening tests, and are therefore not reliable for risk assessment purposes, they do suggest that passerine birds may be significantly more sensitive to carbaryl exposure than non-passerine birds. The registrant is strongly encouraged to submit acute oral toxicity tests with passerine avian species.

The acute RQs for granular carbaryl are based on a rock dove LD_{50} of 1,000 (Table 6). The avian acute, restricted use, and endangered species LOCs are exceeded for birds in the 20 g weight class, for all granular carbaryl uses. Although for most uses the acute LOC is not exceeded for birds in the two higher weight classes, for the trees/ornamentals, turfgrass, and tick control uses the avian acute risk LOC is also exceeded for birds in the 180 g weight class. No acute LOCs are exceeded for birds in the 1000 g weight class for any of the granular carbaryl uses.

Table 6. Avian acute risk quotients for granular carbaryl (broadcast, unincorporated) based on LD_{50} for rock dove (1,000 mg/kg)

Uses	Rate in lb ai/A	LD_{50} (mg/kg)	Body Weight (g)	Acute RQ[1] (LD_{50}/ft^2)
Asparagus, *Brassica* crops (broccoli, Brussels sprouts, cabbage, cauliflower, collards, etc.), corn (field, sweet), sorghum, Solanaceous crops (tomato, pepper, eggplant), Leafy vegetables (celery, endive, lettuce, parsley, spinach, etc.), Roots and tubers (garden beets, carrots, radishes, potatoes, etc.), strawberries	2	1000 1000 1000	20 180 1000	1.04 0.16 0.02
Cucurbits (cucumber, melon, pumpkin, squash)	1	1000 1000 1000	20 180 1000	0.52 0.06 0.01
Legumes (beans, peas, lentils, cowpeas, southern peas) , wheat, millet, sugar beets	1.5	1000 1000 1000	20 180 1000	0.78 0.09 0.02
Trees and ornamentals, turfgrass, tick control	9.15	1000 1000 1000	20 180 1000	4.76 0.53 0.10

[1] $RQ = \frac{\text{App. Rate (lb ai/a)} * (453{,}590 \text{ mg/lb}/43{,}560 \text{ ft}^2/\text{a})}{LD_{50} \text{ mg/kg} * \text{Weight of Animal (kg)}}$

Mammalian acute and chronic risk

Estimating the potential for adverse effects to wild mammals is based upon EFED's draft 1995 SOP of mammalian risk assessments and methods used by Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994). The concentration of carbaryl in the diet that is expected to be acutely lethal to 50% of the test population (LC_{50}) is determined by dividing the LD_{50} value (usually rat LD_{50}) by the % (decimal of) body weight consumed. A risk quotient is then determined by dividing the EEC by the derived LC_{50} value. Risk quotients are calculated for three separate weight classes of mammals (15, 35, and 1000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds). The acute risk quotients for broadcast applications of nongranular products are tabulated below.

Risk from Exposure to Nongranular Products

Short grass

The mammalian acute risk LOC is exceeded for all registered nongranular carbaryl uses, at maximum label application rates, for short grass feeders with a daily food consumption equal to 95% and 66% of their body weight, with RQ values ranging from 0.76 to 12.12 and from 0.53 to 8.42, respectively (Table 7). The acute risk LOC for herbivores consuming daily 15% of their body weight are exceeded for all uses (RQs: 0.56 - 1.91), except for the rice, sugar beets, wheat, millet, flax, pasture, grasses, noncropland, alfalfa, clover, and rangeland use site scenarios.

Broadleaf/forage plans and small insects

The acute risk LOC is exceeded for all nongranular carbaryl uses for small mammals feeding on broadleaf/forage plants and small insects, with RQs in the 0.80 - 6.82 range for mammals with a daily food consumption equal to 95% of their body weights. It is also exceeded for all uses, except rangeland, for mammals consuming 66% of their body weights (RQs: 0.55 to 4.74). For mammals consuming 15 % of their body weight, the acute risk LOC is reached or exceeded for citrus, olives, pome fruits, stone fruits, tree nuts, sweet corn, asparagus, small fruits, berries, and turfgrass (RQs: 0.52 - 1.08). RQs equal or exceed the acute restricted use or the endangered species LOCs for most other uses.

Fruit, pods, seeds, and large insects

For small mammals consuming 95% of these food items, the acute risk LOC is exceeded for citrus, olives, tree nuts, sweet corn, and turfgrass (RQs: 0.62 - 0.76). For mammals consuming 66% of their body weight the acute risk LOC is exceeded only for citrus in California (RQ: 0.53). For mammals that consume 15% of their body weight, the acute risk LOC is not exceeded for any use.

Table 7. Mammalian (herbivore/insectivore) acute risk quotients for multiple applications of nongranular carbaryl (broadcast) based on a rat LD_{50} of 301 mg/kg and maximum label use rates.

Uses, Application Rate, No. Applications, Interval	Body Weight (g)	% Body Weight Con_ sumed	LC_{50} (LD_{50}/% Body Wt Con_ sumed	EEC: Short Grass (ppm)	EEC: Forage & Small Insects (ppm)	EEC: Fruit, Seeds, Lg Insects (ppm)	Acute RQ: Short Grass	Acute RQ: Forage & Small Insects	Acute RQ: Large Insects
Citrus, 5 lb ai/A, 4 appl, 14 days	15	95	316.84	3320.98	1868.05	207.56	10.48	5.90	0.66
	35	66	456.06	3320.98	1868.05	207.56	7.28	4.10	0.46
	1000	15	2006.67	3320.98	1868.05	207.56	1.65	0.93	0.10
Citrus (California), 16 lb ai/A, 1 appl	15	95	316.84	3840.00	2160.00	240.00	12.12	6.82	0.76
	35	66	456.06	3840.00	2160.00	240.00	8.42	4.74	0.53
	1000	15	2006.67	3840.00	2160.00	240.00	1.91	1.08	0.12
Olives, 7.5 lb ai/A 2 appl, 14 days	15	95	316.84	3164.15	1779.83	197.76	9.99	5.62	0.62
	35	66	456.06	3164.15	1779.83	197.76	6.94	3.90	0.43
	1000	15	2006.67	3164.15	1779.83	197.76	1.58	0.89	0.10
Pome fruits (apples, etc.), 3 lb ai/A, 5 appl, 14 days	15	95	316.84	2230.10	1254.43	139.38	7.04	3.96	0.44
	35	66	456.06	2230.10	1254.43	139.38	4.89	2.75	0.31
	1000	15	2006.67	2230.10	1254.43	139.38	1.11	0.63	0.07
Stone fruits (peaches, etc.), 4 lb ai/A, 3 appl, 14 days	15	95	316.84	2238.92	1259.39	139.93	7.07	3.97	0.44
	35	66	456.06	2238.92	1259.39	139.93	4.91	2.76	0.31
	1000	15	2006.67	2238.92	1259.39	139.93	1.12	0.63	0.07
Tree nuts (pistachios, etc.), 5 lb ai/A, 3 appl, 7 days	15	95	316.84	3154.09	1774.18	197.13	9.95	5.60	0.62
	35	66	456.06	3154.09	1774.18	197.13	6.92	3.89	0.43
	1000	15	2006.67	3154.09	1774.18	197.13	1.57	0.88	0.10
Corn, field, 2 lb ai/A 4 appl, 14 days	15	95	316.84	1328.39	747.22	83.02	4.19	2.36	0.26
	35	66	456.06	1328.39	747.22	83.02	2.91	1.64	0.18
	1000	15	2006.67	1328.39	747.22	83.02	0.66	0.37	0.04
Corn, sweet, 2 lb ai/A 8 appl, 3 days	15	95	316.84	3148.03	1770.77	196.75	9.94	5.59	0.62
	35	66	456.06	3148.03	1770.77	196.75	6.90	3.88	0.43
	1000	15	2006.67	3148.03	1770.77	196.75	1.57	0.88	0.10
Rice (tadpole shrimp), sunflower, 1.5 lb ai/A, 2 appl, 7 days	15	95	316.84	673.40	378.79	42.09	2.13	1.20	0.13
	35	66	456.06	673.40	378.79	42.09	1.48	0.83	0.09
	1000	15	2006.67	673.40	378.79	42.09	0.34	0.19	0.02
Sugar beets, wheat, millet, flax, pasture, grasses, noncropland 1.5 lb ai/A, 2 appl, 14 days	15	95	316.84	632.83	355.97	39.55	2.00	1.12	0.12
	35	66	456.06	632.83	355.97	39.55	1.39	0.78	0.09
	1000	15	2006.67	632.83	355.97	39.55	0.32	0.18	0.02
Asparagus, 2 lb ai/A, 5 appl, 3 days	15	95	316.84	2138.64	1202.99	133.67	6.75	3.80	0.42
	35	66	456.06	2138.64	1202.99	133.67	4.69	2.64	0.29
	1000	15	2006.67	2138.64	1202.99	133.67	1.07	0.60	0.07
Cucurbits (cucumbers melons, squash, etc.), trees & ornamentals, 1 lb ai/A, 6 appl, 7 days	15	95	316.84	1047.00	588.94	65.44	3.30	1.86	0.21
	35	66	456.06	1047.00	588.94	65.44	2.30	1.29	0.14
	1000	15	2006.67	1047.00	588.94	65.44	0.56	0.29	0.03

Solanaceous (peppers, tomatoes, eggplant), sweet potatoes, peanuts, tobacco, 2 lb ai/A, 4 appl, 7 days	15 35 1000	95 66 15	316.84 456.06 2006.67	1578.32 1578.32 1578.32	887.80 887.80 887.80	98.64 98.64 98.64	4.98 3.46 0.79	2.80 1.95 0.44	0.31 0.22 0.05

Table 7. Mammalian (herbivore/insectivore) acute risk quotients for multiple applications of nongranular carbaryl (broadcast) based on a rat LD_{50} of 301 mg/kg and maximum label use rates.

Uses, Application Rate, No. Applications, Interval	Body Weight (g)	% Body Weight Con_ sumed	LC_{50} (LD_{50}/% Body Wt Con_ sumed	EEC: Short Grass (ppm)	EEC: Forage & Small Insects (ppm)	EEC: Fruit, Seeds, Lg Insects (ppm)	Acute RQ: Short Grass	Acute RQ: Forage & Small Insects	Acute RQ: Large Insects
Leafy veg (celery, lettuce, etc.), *Brassica* (broccoli, cabbage, etc.), roots & tubers (carrots, potatoes, etc.), sorghum, 2 lb ai/A, 3 appl, 7 days	15 35 1000	95 66 15	316.84 456.06 2006.67	1261.64 1261.64 1261.64	709.67 709.67 709.67	78.85 78.85 78.85	3.98 2.77 0.63	2.24 1.56 0.35	0.25 0.17 0.04
Legumes (beans, peas, lentils, cowpeas), 1.5 lb ai/A, 4 appl, 7 days	15 35 1000	95 66 15	316.84 456.06 2006.67	1183.74 1183.74 1183.74	665.85 665.85 665.85	73.98 73.98 73.98	3.74 2.60 0.59	2.10 1.46 0.33	0.23 0.16 0.04
Small fruits & berries (grapes, strawberries, etc.), 2 lb ai/A, 5 appl 7 days	15 35 1000	95 66 15	316.84 456.06 2006.67	1854.01 1854.01 1854.01	1042.88 1042.88 1042.88	115.88 115.88 115.88	5.85 4.07 0.92	3.29 2.29 0.52	0.37 0.25 0.06
Alfalfa, clover, 1.5 lb ai/A, 10 appl, 30 days	15 35 1000	95 66 15	316.84 456.06 2006.67	796.72 796.72 796.72	448.15 448.15 448.15	49.79 49.79 49.79	2.53 1.76 0.40	1.42 0.99 0.22	0.16 0.11 0.02
Rangeland, 1 lb ai/A, 1 appl	15 35 1000	95 66 15	316.84 456.06 2006.67	240.00 240.00 240.00	135.00 135.00 135.00	15.00 15.00 15.00	0.76 0.53 0.12	0.43 0.30 0.07	0.05 0.03 0.01
Forested areas (non-urban), 1 lb ai/A, 2 appl, 7 days	15 35 1000	95 66 15	316.84 456.06 2006.67	448.93 448.93 448.93	252.52 252.52 252.52	28.06 28.06 28.06	1.42 0.98 0.22	0.80 0.55 0.13	0.09 0.06 0.01
Turfgrass, 8 lb ai/A, 2 appl, 7 days	15 35 1000	95 66 15	316.84 456.06 2006.67	3591.46 3591.46 3591.46	2020.19 2020.19 2020.19	224.47 224.47 224.47	11.34 7.87 1.79	6.38 4.43 1.01	0.71 0.49 0.11

Although neither the acute risk nor the acute restricted use LOC is exceeded for granivores for any of the nongranular carbaryl uses, the acute endangered species LOC is reached or exceeded for citrus, olives, pome and stone fruits, tree nuts, sweet corn, and turfgrass (RQs: 0.10 - 0.16), and for citrus, olives, tree nuts, sweet corn, and turfgrass (RQs: 0.10 - 0.12), for granivores with daily food consumption equal to 21% and 15% of their body weight, respectively (Table 8). No acute LOCs are exceeded for granivores which consume daily 3% of their body weight.

Table 8. Mammalian (granivore) acute risk quotients for multiple applications of nongranular carbaryl (broadcast) based on a rat LD_{50} of 301 mg/kg and maximum label use rates.

Uses, Application Rate, No. Applications, Interval	Body Weight (g)	% Body Weight Consumed	LC_{50} (LD_{50} ÷ % Body Weight Consumed)	EEC: Seeds (ppm)	Acute RQ: Seeds
Citrus, 5 lb ai/A, 4 appl, 14 days	15	21	1433.33	207.56	0.14
	35	15	2000.67	207.56	0.10
	1000	3	10033.33	207.56	0.02
Citrus (California), 16 lb ai/A, 1 appl	15	21	1433.33	240.00	0.16
	35	15	2000.67	240.00	0.12
	1000	3	10033.33	240.00	0.00
Olives, 7.5 lb ai/A, 2 appl, 14 days	15	21	1433.33	197.76	0.14
	35	15	2000.67	197.76	0.10
	1000	3	10033.33	197.76	0.02
Pome fruits (apple, pear, etc.), 3 lb ai/A, 3 appl, 14 days	15	21	1433.33	139.38	0.10
	35	15	2000.67	139.38	0.07
	1000	3	10033.33	139.38	0.01
Stone fruits (peach, apricot, etc.), 4 lb ai/A, 3 appl, 14 days	15	21	1433.33	139.93	0.10
	35	15	2000.67	139.93	0.07
	1000	3	10033.33	139.93	0.01
Tree nuts (pistachios, etc.), 5 lb ai/A, 3 appl, 7 days	15	21	1433.33	197.13	0.13
	35	15	2000.67	197.13	0.10
	1000	3	10033.33	197.13	0.02
Corn, field, 2 lb ai/A, 4 appl, 14 days	15	21	1433.33	83.02	0.06
	35	15	2000.67	83.02	0.04
	1000	3	10033.33	83.02	0.02
Corn, sweet, 2 lb ai/A, 8 appl, 3 days	15	21	1433.33	196.75	0.13
	35	15	2000.67	196.75	0.10
	1000	3	10033.33	196.75	0.00
Rice, sunflower, 1.5 lb ai/A, 2 appl, 7 days	15	21	1433.33	42.09	0.03
	35	15	2000.67	42.09	0.02
	1000	3	10033.33	42.09	0.00
Sugar beets, wheat & millet, flax, pasture, grasses, noncropland, 1.5 lb ai/A, 2 appl, 14 days	15	21	1433.33	39.55	0.03
	35	15	2000.67	39.55	0.02
	1000	3	10033.33	39.55	0.00
Asparagus, 4 lb ai/A, 2 appl, 7 days	15	21	1433.33	133.67	0.09
	35	15	2000.67	133.67	0.07
	1000	3	10033.33	133.67	0.01
Brassica crops (broccoli, cabbage, etc.), leafy veg (celery, lettuce, etc.), Roots & tubers (beets, carrot, potato, etc.), sorghum, 2 lb ai/A, 3 appl, 7 days	15	21	1433.33	78.85	0.05
	35	15	2000.67	78.85	0.04
	1000	3	10033.33	78.85	0.01
Cucurbits (cucumbers, melons, squash, etc.), trees and ornamentals, 1 lb ai/A, 6 appl, 7 days	15	21	1433.33	65.44	0.04
	35	15	2000.67	65.44	0.03
	1000	3	10033.33	65.44	0.01
Solanaceous (pepper, tomato, eggplant), sweet potato, peanuts, tobacco, 2 lb ai/A, 4 appl, 7 days	15	21	1433.33	98.64	0.07
	35	15	2000.67	98.64	0.05
	1000	3	10033.33	98.64	0.01

Legumes (beans, peas, lentils, cowpeas), 1.5 lb ai/A, 4 appl, 7 days	15	21	1433.33	73.98	0.05
	35	15	2000.67	73.98	0.04
	1000	3	10033.33	73.98	0.01

Table 8. Mammalian (granivore) acute risk quotients for multiple applications of nongranular carbaryl (broadcast) based on a rat LD_{50} of 301 mg/kg and maximum label use rates.

Uses, Application Rate, No. Applications, Interval	Body Weight (g)	% Body Weight Consumed	LC_{50} (LD_{50} ÷ % Body Weight Consumed)	EEC: Seeds (ppm)	Acute RQ: Seeds
Small fruits & berries (grapes, strawberries, etc.), 2 lb ai/A, 5 appl 7 days	15	21	1433.33	115.88	0.08
	35	15	2000.67	115.88	0.06
	1000	3	10033.33	115.88	0.01
Alfalfa, clover, 1.5 lb ai/A, 10 appl, 30 days	15	21	1433.33	49.79	0.03
	35	15	2000.67	49.79	0.02
	1000	3	10033.33	49.79	0.00
Rangeland, 1 lb ai/A, 1 appl	15	21	1433.33	15.00	0.01
	35	15	2000.67	15.00	0.01
	1000	3	10033.33	15.00	0.00
Forested areas (non-urban), 1 lb ai/A, 2 appl, 7 days	15	21	1433.33	28.06	0.02
	35	15	2000.67	28.06	0.01
	1000	3	10033.33	28.06	0.00
Turfgrass, 8 lb ai/A, 2 appl, 7 days	15	21	1433.33	224.47	0.15
	35	15	2000.67	224.47	0.11
	1000	3	10033.33	224.47	0.02

As summarized in Table 9, at maximum label application rates, the mammalian chronic LOC (1) is exceeded for all registered uses of nongranular carbaryl for all food item groups, with chronic RQ values in the range of: 3.0 - 48.0 (for short grasses), 1.4 - 22.0 (for tall grasses), and 1.7 - 27.0 (for broadleaf/ forage plants, small insects). The mammalian chronic LOC is exceeded for the fruits/pods/seeds/ large insects food items for the following uses: citrus, olives, pome and stone fruits, tree nuts, field and sweet corn, asparagus, solanaceous vegetable crops, sweet potatoes, peanuts, tobacco, small fruits and berries, and turfgrass (chronic RQs = 1.0 - 3.0).

Table 9. Mammalian chronic risk quotients for multiple applications of nongranular carbaryl (broadcast) based on a developmental rat NOAEC of 80 ppm and maximum label application rates

Site, Application Rate, Number of Applications, Interval	Food Items	Peak Mean EEC (ppm)	Chronic RQ (EEC)/NOAEC)
Citrus, 5 lb ai/A, 4 appl, 14 days	Short Grass	3320.98	41.51
	Tall Grass	1522.12	19.03
	Broad Leaf	1868.05	23.35
	Seed Fruit	207.56	2.59
Citrus (California), 16 lb ai/A, 1 appl	Short Grass	3840.00	48.00
	Tall Grass	1760.00	22.00
	Broad Leaf	2160.00	27.00
	Seed Fruit	240.00	3.00
Olives, 7.5 lb ai/A, 2 appl, 14 days	Short Grass	3164.15	39.55
	Tall Grass	1450.23	18.13
	Broad Leaf	1779.83	22.25
	Seed Fruit	197.76	2.47
Pome fruits (apples, etc.), 3 lb ai/A, 5 appl, 14 days	Short Grass	2230.10	27.88
	Tall Grass	1022.13	12.78
	Broad Leaf	1254.43	15.68
	Seed Fruit	139.38	1.74
Stone fruits (peaches, etc.), 4 lb ai/A, 3 appl, 14 days	Short Grass	2238.92	27.99
	Tall Grass	1026.17	12.83
	Broad Leaf	1259.39	15.74
	Seed Fruit	139.93	1.75
Tree nuts (pistachios, etc.), 5 lb ai/A, 3 appl, 7 days	Short Grass	3154.09	39.43
	Tall Grass	1445.62	18.07
	Broad Leaf	1774.18	22.18
	Seed Fruit	197.13	2.46
Corn, field, 2 lb ai/A, 4 appl, 14 days	Short Grass	1328.39	16.60
	Tall Grass	608.85	7.61
	Broad Leaf	747.22	9.34
	Seed Fruit	83.02	1.04
Corn, sweet, 2 lb ai/A, 8 appl, 3 days	Short Grass	3148.03	39.35
	Tall Grass	1442.85	18.04
	Broad Leaf	1770.77	22.13
	Seed Fruit	196.75	2.46
Rice, sunflower, 1.5 lb ai/A, 2 appl, 7 days	Short Grass	673.40	8.42
	Tall Grass	308.64	3.86
	Broad Leaf	378.79	4.73
	Seed Fruit	42.09	0.53
Asparagus, 2 lb ai/A, 5 appl, 3 days	Short Grass	2138.64	26.73
	Tall Grass	980.21	12.25
	Broad Leaf	1202.99	15.04
	Seed Fruit	133.67	1.67
Brassica crops (broccoli, cabbage, etc.), leafy veg (celery, lettuce, etc.), roots & tubers (beets, carrots, potatoes, etc.), sorghum, 2 lb ai/A, 3 appl, 7 days	Short Grass	1261.64	15.77
	Tall Grass	578.25	7.23
	Broad Leaf	709.67	8.87
	Seed Fruit	78.85	0.99

Table 9. Mammalian chronic risk quotients for multiple applications of nongranular carbaryl (broadcast) based on a developmental rat NOAEC of 80 ppm and maximum label application rates

Site, Application Rate, Number of Applications, Interval	Food Items	Peak Mean EEC (ppm)	Chronic RQ (EEC)/NOAEC)
Cucurbits (cucumbers melons, squash, etc.), trees and ornamentals, 1 lb ai/A, 6 appl, 7 days	Short Grass	1047.00	13.09
	Tall Grass	479.88	6.00
	Broad Leaf	588.94	7.36
	Seed Fruit	65.44	0.82
Solanaceous (peppers, tomatoes, eggplant), sweet potatoes, peanuts, tobacco, 2 lb ai/A, 4 appl, 7 days	Short Grass	1578.32	19.73
	Tall Grass	723.40	9.04
	Broad Leaf	887.80	11.10
	Seed Fruit	98.64	1.23
Legumes (beans, peas, lentils, cowpeas), 1.5 lb ai/A, 4 appl, 7 days	Short Grass	1183.74	14.80
	Tall Grass	542.55	6.78
	Broad Leaf	665.85	8.32
	Seed Fruit	73.98	0.92
Sugar beets, wheat, millet, flax, pasture, grasses, non-cropland, 1.5 lb ai/A, 2 appl, 14 days	Short Grass	632.83	7.91
	Tall Grass	290.05	3.63
	Broad Leaf	355.97	4.45
	Seed Fruit	39.55	0.49
Small fruits & berries (grapes, strawberries, etc.), 2 lb ai/A, 5 appl, 7 days	Short Grass	1854.01	23.18
	Tall Grass	849.75	10.62
	Broad Leaf	1042.88	13.04
	Seed Fruit	115.88	1.45
Alfalfa, clover, 1.5 lb ai/A, 8 appl, 30 days	Short Grass	796.72	9.96
	Tall Grass	365.16	4.56
	Broad Leaf	448.15	5.60
	Seed Fruit	49.79	0.62
Rangeland, 1 lb ai/A, 1 appl	Short Grass	240.00	3.00
	Tall Grass	110.00	1.38
	Broad Leaf	135.00	1.69
	Seed Fruit	15.00	0.19
Forested areas (non-urban), 1 lb ai/A, 2 appl, 7 days	Short Grass	448.93	5.61
	Tall Grass	205.76	2.57
	Broad Leaf	252.52	3.16
	Seed Fruit	28.06	0.35
Turfgrass, 8 lb ai/A, 2 appl, 7 days	Short Grass	3591.46	44.89
	Tall Grass	1646.08	20.58
	Broad Leaf	2020.19	25.25
	Seed Fruit	224.47	2.81

In addition to maximum label use rates, mammalian acute and chronic RQs were also calculated for nongranular carbaryl using QUA average use rates data available for for 70 uses (Table 10a) and maximum reported (Doane data) use rates data available for 42 uses (Table 10b).

As summarized in Table 10a, when RQs are based on QUA average rates, the acute risk LOC is exceeded for 63 uses, whereas the restricted use LOC is exceeded for 69 uses (not exceeded only for Chinese cabbage), and the endangered species LOC is exceeded for all 70 uses. The chronic risk LOC is exceeded for 69 uses (not exceeded only for Chinese cabbage).

Table 10a. **Mammalian (herbivores) highest acute and chronic risk quotients[1] for nongranular carbaryl based on a rat LD_{50} of 301 mg/kg ppm, a developmental rat NOAEC of 80 ppm, and QUA average application rates for 70 uses**

Use site	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)	Use Site	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)
Alfalfa	0.84	3.30	Nectarines	2.88	11.40
Almonds	1.59	6.30	Okra	1.44	5.70
Apples	0.91	4.11	Olives	4.02	15.90
Asparagus	0.68	2.70	Oranges	2.58	10.20
Beans, Dry	0.38	1.50	Pasture	0.68	2.70
Beans, Lima, Fresh	0.68	2.70	Peaches	1.99	7.89
Beans, Snap, Fresh	1.28	5.05	Peanuts	0.60	2.40
Beans, Snap, Processed	0.99	3.93	Pears	1.34	5.27
Beets	0.38	1.50	Pears, Dry	0.75	3.00
Blackberries	1.28	5.10	Peas, Green	1.13	4.50
Blueberries	1.28	5.10	Pecans	1.98	7.86
Broccoli	0.60	2.40	Peppers, Bell	1.28	5.05
Brussels Sprouts	0.68	2.70	Peppers, Sweet	0.99	3.90
Chinese Cabbage	0.15	0.60	Pistachios	2.72	10.80
Fresh Cabbage	1.42	5.61	Plums	2.88	11.40
Cantaloupes	0.60	2.40	Potatoes	1.13	4.49
Carrots	1.28	5.05	Pumpkins	2.84	11.22
Cauliflower	0.84	3.30	Raspberries	2.12	8.40
Celery	1.42	5.61	Rice	0.84	3.30
Cherries	1.44	5.70	Sorghum	0.84	3.30
Citrus, other	2.40	9.49	Soybeans	0.68	2.70
Corn, Field	0.75	3.00	Squash	1.06	4.20
Cranberries	1.52	6.00	Strawberries	1.98	7.86
Cucumbers	0.84	3.30	Sugar Beets	0.99	3.90
Cucumbers, Processed	0.85	3.37	Sunflower	0.31	2.10
Eggplant	1.42	5.61	Sweet Corn, Fresh	2.78	11.04
Flax	0.84	3.30	Sweet Potatoes	1.21	4.80
Grapefruit	1.87	7.38	Tobacco	1.42	5.61
Grapes	1.98	7.86	Tomatoes, Fresh	1.40	5.52
Hay	0.60	2.40	Tomatoes, Processed	0.91	3.60
Hazelnuts	1.90	7.50	Walnuts	1.44	5.70
Lemons	2.05	8.10	Watermelons	0.38	1.50
Lettuce	0.84	3.30	Wheat, Spring	0.46	1.80
Lots/Farmsteads	0.70	2.80	Wheat, Winter	0.60	2.40
Melons	0.53	2.10	Woodland	0.31	2.10

[1]Only the highest RQs -- i.e. those corresponding to 15 g mammals which have a daily food consumption equal to 95% of their body weight and based on short grass EECs -- are included in this table.

When RQs are calculated using maximum reported application rates, the acute risk LOC is exceeded for 41 of the 42 uses (RQs: 0.60 - 11.36). The restricted use, endangered species, and chronic (RQs: 1.5 - 45) risk LOCs are exceeded for all 42 uses (Table 10b).

Table 10b	Mammalian (herbivores) highest acute and chronic risk quotients[1] for nongranular carbaryl based on a rat LD_{50} of 301 mg/kg ppm and, a developmental rat NOAEC of 80 ppm, and maximum reported use rates (Doane data) for 42 uses				
Use site [appl.rate (lb ai/A), No. appl]	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)	Use Site [appl.rate (lb ai/A) No. appl]	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)
Alfalfa (1.5, 1)	1.13	4.5	Peaches (5, 1)	3.78	15.0
Almonds (4, 1)	3.03	12.0	Peanuts (2, 1)	1.52	6.0
Apples (3.2, 1)	2.43	9.62	Pears (2, 1)	1.52	6.0
Apricots (4, 1)	3.03	12.0	Pecans (3, 2, 7)	4.25	16.8
Asparagus (4, 1)	3.03	12.0	Peppers (2, 1)	1.52	6.0
Beans, Lima (1.3,1)	0.99	3.9	Pistachios (5, 1)	3.78	15.0
Beans, snap (1.6, 1)	1.21	4.8	Plums (4, 1)	3.03	12.0
Cabbage (2,1)	1.52	6.0	Potatoes (1.5, 1)	1.13	4.5
Canola (0.5, 1)	0.38	1.5	Pumpkins (1.5, 1)	1.13	4.5
Cantaloupe (1.2, 1)	0.91	3.6	Rice (1.3, 1)	0.99	3.9
Carrots (0.8, 1)	0.60	2.4	Sorghum (0.5, 1)	0.38	1.5
Cauliflower (1, 1)	0.75	3.0	Squash (1.2, 1)	0.91	3.6
Celery (2, 1)	1.53	6.0	Sugar Beets (1.2, 1)	0.91	3.6
Cherries (5, 1)	3.78	15.0	Sunflower (1, 1)	0.75	3.0
Corn, Field (1.5, 2, 14)	2.00	7.9	Strawberries (2,1)	1.52	6.0
Cucumbers (1, 1)	0.75	3.0	Sweet Corn (1.5, 2, 3)	2.20	8.7
Grapefruit (12.8, 1)	9.70	38.4	Tobacco (2, 1)	1.52	6.0
Grapes (2.5,1)	1.90	7.5	Tomatoes (2,1)	1.52	6.0
Lemons (8,1)	6.06	24.0	Walnuts (4, 1)	3.03	12.0
Lettuce (1, 1)	0.75	3.0	Watermelons (2, 1)	1.52	6.0
Oranges (15, 1)	11.36	45.0	Wheat (1,1)	0.75	3.0

[1]Only the highest RQs -- i.e. those corresponding to 15 g mammals which have a daily food consumption equal to 95% of their body weight and based on short grass EECs -- are included in this table.

Risk to Granular Products

Mammals also may be exposed to granular/bait pesticides through ingestion and by other routes, such as by walking on exposed granules or by drinking water contaminated with granules. The number of lethal doses (LD_{50}) that are available within one square foot immediately after application (LD_{50}/ft2) is used as the risk quotient for granular/bait products. Risk quotients are calculated for small mammals in three weight classes: 15 g, 35 g, and 1000 g.

The acute level of concern is exceeded for mammals in the 15 g and 35 g categories for all 40 registered granular uses (Table 11). For 1000 g mammals, the restricted use and endangered species LOCs are exceeded for applications to trees and ornamentals, turfgrass, and tick control.

Table 11. Mammalian acute risk quotients for granular carbaryl (broadcast, unincorporated) based on a rat LD_{50} of 301 mg/kg

Uses	Rate in lb ai/A	Body Weight (g)	Acute RQ[1] (LD_{50}/ft^2)
Asparagus, *Brassica* crops (broccoli, cabbage, cauliflower, collards, etc.), corn (field, sweet), sorghum, solanaceous crops (tomato, pepper, eggplant), leafy vegetables (celery, lettuce, parsley, spinach, etc.), roots & tubers (beets, carrots, radishes, potatoes, etc.), strawberries	2	15	4.61
		35	1.98
		1000	0.07
Cucurbits (cucumber, melon, pumpkin, squash)	1	15	2.30
		35	0.99
		1000	0.03
Legumes (beans, peas, lentils, cowpeas, southern peas), Wheat, millet, Sugar beets	1.5	15	3.45
		35	1.48
		1000	0.05
Trees and ornamentals, turfgrass, tick control	9.15	15	21.10
		35	9.04
		1000	0.32

[1] $RQ = \dfrac{\text{Appl. rate (lb ai/a)} * (453{,}590 \text{ mg/lb}/43{,}560 \text{ ft}^2\text{/a})}{LD_{50} \text{ mg/kg} * \text{weight of animal (kg)}}$

Insects

Currently EFED does not assess risk to nontarget insects. However, data from acceptable studies are used to recommend appropriate label precautions. Carbaryl, is highly toxic to domestic and wild bees and should be applied only under the conditions specified by the latest pollinator protection label language. Carbaryl has also been shown to be from moderately to highly toxic to predaceous and parasitic arthropods, including lace bugs, big eyed bugs, lady beetles, carabid ground beetles, hymenopterous parasitoids, predaceous mites, and spiders.

Terrestrial Plants

There in no data to assess risk to terrestrial plants. However, based on precautionary label language about potential injury to several crop plants, the registrant needs to submit tier I and, if necessary, tier II Seed Germination and Seedling Emergence and Vegetative Vigor studies.

Exposure and Risk to Nontarget Aquatic Animals

EFED calculates estimated environmental concentrations (EECs) using the PRZM/ EXAMS model. The EECs are used for assessing acute and chronic risks to aquatic organisms. Acute risk assessments are performed using peak EEC values for single and multiple applications. Chronic risk assessments are performed using the 21-day EECs for invertebrates and 56-day EECs for fish.

The PRZM/EXAMS program uses basic environmental fate data and pesticide label application information to estimate the expected EECs following treatment of 10 hectares. The model calculates the concentration (EEC) of a pesticide in a one hectare, two meter deep pond, taking into account the following: (1) adsorption to soil or sediment, (2) soil incorporation, (3) degradation in soil before washoff to a water body, and (4) degradation within the water body. The model also accounts for direct deposition of spray drift into the water body (assumed to be 1% and 5% of the application rate for ground and aerial applications, respectively). The environmental fate parameters used in the model for this pesticide are: soil K_{OC} 211, solubility: 32 mg/L, aerobic soil metabolism half-life of 4 days, hydrolysis: stable at pH 5, 12 days at pH 7, 5 hrs at Ph9, water photolysis 21 days, aerobic aquatic metabolism half-life: 4.9, anaerobic aquatic metabolism half-life: 4.9 days. EECs are tabulated in Table 12.

Table 12. Tier II surface water estimated environmental concentration (EEC) values derived from PRZM/ EXAMS modeling for use in ecorisk assessment (Calculated using standard pond.)

Use Site, Application Method		Number of Applications Per Year	Application Rate (Pounds A.I. per Application)	Surface Water Acute (ppb) (1 in 10 year peak single day concentration)	21 day (ppb) (1 in 10 year)	60 day (ppb) (1 in 10 year)
Sweet Corn (OH), air/ground	Maximum "Average" Maximum Reported	8 2 3	2 3.4 1	46 16 14	26 10 8	21 5 4
Field Corn (OH), air/ground	Maximum "Average" Maximum Reported	4 2 2	2 1 1.5	28 12 18	16 6 9.5	10 3 5
Apples (OR), air/ground	Maximum "Average" Maximum Reported	5 2 2	2 1.2 1.6	8.6 4.5 6.0	4.9 2.5 3	4 1 2
Sugar Beets (MN), air/ground	Maximum "Average" Maximum Reported	2 1 1	1.5 1.5 1.2	19 14 11	11 7 5	5 3 2
Citrus (FL), air/ground	Maximum "Average" Maximum Reported	4 2 3	5 3.4 4.3	274 145 232	137 67 112	79 33 55

Freshwater Fish

Acute and chronic risk quotients for freshwater fish, based on maximum label, QUA average, and maximum reported (Doane data) use rates are tabulated in Table 13. The acute risk LOC is exceeded only for the citrus scenario, for all three use rates modeled, whereas the endangered species LOC is met or exceeded for four scenarios, for all three use rates. The chronic risk LOC is is not exceeded for any use scenario, for any use rates.

Table 13. Risk quotients for freshwater fish based on an Atlantic salmon LC_{50} of 250 ppb and a fathead minnow NOAEC of 210 ppb, at maximum label use rates, QUA average use rates, and maximum reported use rates

Site/Appl. Method	Use Rates	LC_{50} (ppb)	NOAEC (ppb)	EEC Initial/ Peak (ppb)	EEC 60-Day Ave. (ppb)	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)
Sweet Corn (OH), air/ground	Maximum	250	210	46	21	0.18	0.10
	"Average"			16	5	0.06	0.02
	Max Rep			14	4	0.06	0.02
Field Corn (OH) air/ground	Maximum	250	210	28	10	0.11	0.05
	"Average"			12	3	0.05	0.01
	Max Rep			18	5	0.07	0.02
Apples (OR) air/ground	Maximum	250	210	8.6	4	0.03	0.02
	"Average"			4.5	1	0.02	0.00
	Max Rep			6.0	2	0.02	0.01
Sugar Beets (MN) air/ground	Maximum	250	210	19	5	0.08	0.02
	"Average"			14	3	0.06	0.01
	Max Rep			11	2	0.04	0.01
Citrus (FL) air/ground	Maximum	250	210	274	79	1.10	0.38
	"Average"			145	33	0.58	0.16
	Max Rep			232	55	0.93	0.26

The risk quotients for freshwater invertebrates exceed both the acute and chronic LOCs for all five use scenarios modeled, at maximum label use rates, QUA average rates, and maximum reported (Doane data) use rates (Table 14).

Table 14. Risk quotients for freshwater invertebrates based on a stonefly EC_{50} of 1.7 ppb and a water flea NOAEC of 1.5 ppb , at maximum label use rates, QUA average use rates, and maximum reported use rates

Site/Appl. Method	Use Rates	EC_{50} (ppb)	NOAEC (ppb)	EEC Initial/ Peak (ppb)	EEC 21-Day Ave. (ppb)	Acute RQ (EEC/EC_{50})	Chronic RQ (EEC/NOAEC)
Sweet Corn (OH)	Maximum	**1.7**	1.5	46	26	27.06	17.33
	"Average"			16	10	9.40	6.67
	Max Rep			14	8	8.20	5.33
Field Corn (OH)	Maximum	**1.7**	1.5	28	16	16.47	10.67
	"Average"			12	6	7.06	4.00
	Max Rep			18	9.5	10.59	6.33
Apples (OR)	Maximum	**1.7**	1.5	8.6	4.9	5.06	3.27
	"Average"			4.5	2.5	2.65	1.67
	Max Rep			6.0	3	3.30	2.00
Sugar Beets (MN)	Maximum	**1.7**	1.5	19	11	11.18	7.33
	"Average"			14	7	8.24	4.67
	Max rep			11	5	6.47	3.33
Citrus (FL)	Maximum	**1.7**	1.5	274	137	161.18	91.33
	"Average"			145	67	85.29	44.67
	Max Rep			232	112	136.47	74.67

Estuarine and Marine Animals

The acute risk LOC is not exceeded for any of the five use scenarios modeled using maximum label use rates, QUA average rates, and maximum reported rates (Table 15). The acute endangered species LOC is exceeded at maximum label rates for the citrus scenario. Due to the unavailability of core chronic toxicity data, it is not possible to evaluate chronic risk to estuarine/ marine fish at this time.

Table 15. Acute risk quotients for estuarine/marine fish based on a sheepshead minnow LC_{50} of 2.6 ppm and label maximum and QUA average use rates, at maximum label use rates, QUA average use rates, and maximum reported use rates

Site/Appl. Method	Use Rates	LC_{50} (ppb)	EEC Initial/Peak (ppb) (Max Rates)	Acute RQ (EEC/EC_{50})
Sweet Corn (OH)	Maximum	2600	46	0.02
	"Average"		16	0.01
	Max Rep		14	0.00
Field Corn (OH)	Maximum	2600	28	0.01
	"Average"		12	0.00
	Max Rep		18	0.01
Apples (OR)	Maximum	2600	8.6	0.00
	"Average"		4.5	0.00
	Max Rep		6.0	0.00
Sugar Beets (MN)	Maximum	2600	19	0.00
	"Average"		14	0.00
	Max rep		11	0.00
Citrus (FL)	Maximum	2600	274	0.10
	"Average"		145	0.06
	Max Rep		232	0.09

The acute risk LOC is exceeded for all five carbaryl use scenarios modeled at maximum label use rates, QUA average rates, and maximum reported (Doane data) rates (Table 16). Due to the unavailability of core chronic toxicity data, it is not possible to evaluate chronic risk to estuarine/ marine fish or invertebrates at this time.

Table 16. Acute risk quotients for estuarine/marine invertebrates based on a mysid LC_{50} of 5.7 ppb and three sets of use rates, at maximum label use rates, QUA average use rates, and maximum reported use rates

Site/Appl. Method	Use Rates	LC_{50} (ppb)	EEC Initial/Peak (ppb) (Max Rates)	Acute RQ (EEC/EC_{50}) (Max Rates)
Sweet Corn (OH)	Maximum	5.7	46	8.07
	"Average"		16	2.81
	Max Rep		14	2.46
Field Corn (OH)	Maximum	5.7	28	4.91
	"Average"		12	2.10
	Max Rep		18	3.16
Apples (OR)	Maximum	5.7	8.6	1.51
	"Average"		4.5	0.79
	Max Rep		6.0	1.05
Sugar Beets (MN)	Maximum	5.7	19	3.33
	"Average"		14	2.46
	Max rep		11	1.93
Citrus (FL)	Maximum	5.7	274	48.07
	"Average"		145	25.44
	Max Rep		232	40.70

Aquatic Plants

Exposure to nontarget aquatic plants may occur through runoff or spray drift from adjacent treated sites or directly from such uses as aquatic weed or mosquito larvae control. An aquatic plant risk assessment for acute risk is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Non-vascular acute risk assessments are performed using either algae or a diatom, whichever is the most sensitive species. An aquatic plant risk assessment for acute-endangered species is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. To date, there are no known non-vascular plant species on the endangered species list. Runoff and drift exposure is computed from GENEEC. The risk quotient is determined by dividing the pesticide's initial or peak concentration in water by the plant EC_{50} value.

Based on a single core aquatic plant toxicity study available, neither the acute risk nor the endangered species LOC is exceeded for any of the five use scenarios modeled, at maximum label, QUA average, and maximum reported use rates (Table 17). However, to fully assess carbaryl risk to aquatic plants, it is recommended that toxicity studies with *Lemna gibba, Anabaena flos-aquae, Skeletonema costatum,* and a freshwater diatom be submitted.

Table 17. Risk quotients for aquatic plants based on a green alga EC_{50} of 1,1 ppm and a NOAEC of 0.37 ppm, at maximum label use rates, QUA average use rates, and maximum reported use rates

Site/Appl. Method	Use Rates	EC_{50} (ppb)	NOAEC (ppb)	EEC Initial/ Peak (ppb)	Acute RQ (EEC/EC_{50})	Acute Endangered Species RQ (EEC/NOAEC)
Sweet Corn (OH)	Maximum	1100	370	46	0.04	0.12
	"Average"			16	0.01	0.04
	Max Rep			14	0.01	0.04
Field Corn (OH)	Maximum	1100	370	28	0.02	0.08
	"Average"			12	0.01	0.03
	Max Rep			18	0.02	0.05
Apples (OR)	Maximum	1100	370	8.6	0.01	0.02
	"Average"			4.5	0.00	0.01
	Max Rep			6.0	0.00	0.02
Sugar Beets (MN)	Maximum	1100	370	19	0.02	0.05
	"Average"			14	0.01	0.04
	Max rep			11	0.01	0.03
Citrus (FL)	Maximum	1100	370	274	0.25	0.74
	"Average"			145	0.13	0.39
	Max Rep			232	0.21	0.63

Endangered Species

The endangered species LOC for birds is met or exceeded for 72 of 74 nongranular carbaryl uses at maximum label use rates, for 18 of 70 carbaryl uses at QUA average use rates, and for 25 of 42 maximum reported use rates.

The acute endangered species LOC for mammals is met or exceeded for all (74) uses at maximum label rates, it is exceeded for all (70) uses at QUA average rates, and it is exceeded for all (42) uses at maximum reported use rates.

Based on five use scenarios modeled (sweet corn, field corn, apples, sugar beets, and citrus) for assessing risk to aquatic organisms, the freshwater fish endangered species LOC is met or exceeded for four use scenarios, at maximum label, QUA average, and maximum reported use rates. The estuarine/marine fish endangered species LOC is exceeded for one scenario (citrus), at all three use rates modeled. The endangered species LOC for both freshwater and estuarine/ marine aquatic invertebrates is exceeded for all five scenarios and all three use rates modeled.

These data indicate that over half of carbaryl uses pose an acute risk to endangered species of birds, while all uses represent an acute risk to endangered species of mammals. With regard to aquatic species, most carbaryl uses are likely to present an acute risk to endangered species of freshwater fish and aquatic invertebrates, both freshwater and marine/ estuarine species. Only the highest use rates (citrus) are likely to pose an acute risk to endangered species of marine/estuarine fish.

Appendix C: Toxicity Assessment

Toxicity Assessment

Toxicity testing reported in this section is not representative of the wide diversity of terrestrial and aquatic organisms in the United States. Two surrogate bird species, the bobwhite quail and the mallard duck, are used to represent the 680+ species of birds found in this country. For mammals, acute studies are usually limited to the Norway rat or the house mouse. Reptiles are not tested, as these are assumed to be subject to similar toxicological effects as birds. Of approximately 100,000 species of insects, spiders, and other terrestrial arthropods, toxicity tests are usually required only for the honey bee. Only two surrogate fish species (rainbow trout and bluegill sunfish) are used to represent the over 2,000 species of freshwater fish found in this country. Amphibians are not tested, as these are assumed to be subject to similar toxicological effects as fish. One crustacean, the water flea, is used to represent all freshwater invertebrates. Estuarine/marine animal acute toxicity testing is usually limited to a crustacean, a mollusk, and a fish.

Toxicity to Terrestrial Animals

Birds, Acute and Subacute Toxicity

Based on a rock dove lower 95% confidence interval LD_{50} of 1,000 mg/kg and a mallard LD_{50} greater than 2,000 mg/kg, technical carbaryl can be classified as slightly to practically nontoxic to birds on an acute basis (Table 1). LD_{50} values for carbaryl as low as 16.2 mg/kg and 56.2 mg/kg have been reported for the starling and the red-winged blackbird, respectively (Schafer et al., 1983). Although these data are based on simple screening tests, and are therefore not reliable for risk assessment purposes, they do suggest that passerine birds may be significantly more sensitive to carbaryl exposure than non-passerine birds. The registrant is strongly encouraged to submit acute oral toxicity tests with passerine avian species. The guideline 71-1 is fulfilled (MRID 00160000).

Table 1. Summary of avian acute oral toxicity for technical grade carbaryl

Species	% ai	LD50 (mg/kg)	Toxicity Category	MRID No. Author/Year	Study Classification[1]
Mallard Duck (*Anas platyrhynchos*)	85	> 2,564	Practically non-toxic	00160000 Hudson *et al.* (1984)	Core
Canada Goose *Branta canadensis*	50	1,790	Slightly toxic	00160000 Hudson *et al.* (1984)	Supplemental
Ring-necked Pheasant male *(Phasianus colchicus)*	95	> 2,000	Practically non-toxic	00160000 Hudson *et al.* (1984)	Supplemental
Ring-necked Pheasant female *(Phasianus colchicus)*	480g/L	707	Moderately toxic	00160000 Hudson *et al.* (1984)	Supplemental
Sharp-tailed grouse *Tympanuchus phasianellus*	85	< 1000	Slightly toxic	00160000 Hudson *et al.* (1984)	Supplemental
California quail *Lophortyx californicus*	480 g/L	> 2000	Practically non-toxic	00160000 Hudson *et al.* (1984)	Supplemental
Rock Dove (*Columba livia)*	85	1,000 - 3000[2]	Slightly toxic to Practically non-toxic	00160000 Hudson *et al.* (1984)	Supplemental

[1] Core study satisfies guideline requirements. Supplemental study is scientifically sound, but does not satisfy guidelines.
[2] 95% confidence interval

Two subacute dietary studies using the TGAI are required to establish the toxicity of carbaryl to birds. The preferred test species are mallard duck and bobwhite quail. Results of these tests are summarized in Table 2. The LC_{50} is higher than 5000 ppm for both species. Therefore, carbaryl is categorized as practically nontoxic to avian species on a subacute dietary basis. An LC_{50} greater than 10,000 ppm has been reported by Hill and Camardese (1986), confirming that carbaryl's low toxicity to birds on a subacture, dietary basis. The guideline 71-2 is fulfilled (MRID 00028757, 00022923).

Table 2 : Summary of avian subacute dietary toxicity for technical grade carbaryl

Species	% ai	5-Day LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Ring-necked Pheasant (*Phasianus calchicus*)	99.8	> 5,000	practically non-toxic	00028757 Hill *et al.* (1975)	Core
Northern bobwhite Quail *(Colinus virginianus)*	99.8	> 5,000	Practically non-toxic	00028757 Hill *et al.* (1975)	Core
Japanese Quail *(Coturnix japonica)*	99.8.	> 5,000	Practically non-toxic	00022923 Hill *et al.* (1975)	Supplemental
Mallard Duck *(Anas platyrhynchos)*	99.8	> 5000	Practically non-toxic	00022923 Hill *et al.* (1975)	Core

According to the Ecological Incident Information System (EIIS) database summarizing 6(a)2 incident reports, bird kills attributed to carbaryl and involving blackbirds, ducks, starlings, grackles turkey, and cardinals have been reported in Pennsylvania, Virginia, New Jersey, North Carolina and Michigan (#1002048-001, #1000802-001, #1007720-020, ##1000799-003, #1004375-004) .

Birds, Chronic Toxicity

Exposure to carbaryl at levels equal to or greater than 1000 ppm in the mallard duck results in adverse reproductive effects, such as decreased number of eggs produced, increased number of cracked eggs, and decreased fertility (Table 3). Guideline 71-4 is fulfilled (ACC263701; MRID 00160044).

Table 3. Summary of avian reproduction toxicity for technical grade carbaryl

Species	% ai	NOAEC (ppm)	LOAC Endpoints	MRID. No. Author/Year	Study Classification
Northern bobwhite Quail *(Colinus virginianus)*	99.9	> 3,000	N/A	00160044 Fletcher (1986)	Core
Mallard Duck *(Anas platyrhynchos)*	99.9	300	Number of eggs produced	ACC263701 Fletcher (1986)	Core

Mammals, Acute and Chronic

As shown in Table 4, carbaryl is categorized as moderately toxic to small mammals on an acute oral basis (LD_{50} = 301 mg/kg). Although at this time two-generation rat reproduction study data are not available, a LOAEC of 600 ppm and a NOAEC of 80 ppm, based on decreased fetal body weights and increased incomplete ossification of multiple bones (from a rat prenatal development study, MRID# 44732901), suggest that carbaryl has the potential for chronic effects in mammals.

Table 4. Summary of mammalian toxicity for technical grade carbaryl

Species	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
Laboratory Rat *(Rattus norvegicus)*	99.0%	Acute oral	LD50 = 301.0 mg/kg	Morbidity	00148500
Laboratory Rat *(Rattus norvegicus)*	99.0%	Prenatal Development	NOAEC/LOAEC 80 / 600 ppm	Decreased fetal body weights and incomplete ossification of multiple bones	44732901
Domestic Dog (*Canis familiaris*)	99.0%	Chronic	NOAEC/LOAEC 45 / 125 ppm	Decreased plasma cholinesterase	40166701 42022801

Incidents involving small mammal kills (squirrels, ground squirrel, mole, rabbit) have been recorded in South Carolina and Virginia (#1000504-039, #1000504-039).

Insect Toxicity

Technical carbaryl is categorized as highly toxic to bees on an acute contact basis (Table 5). Guideline 141-1 is fulfilled (MRID 00036935, 05001991, 05004151).

Table 5. Summary of honey bee acute contact toxicity for technical grade carbaryl

Species	% ai	Contact LD_{50} (µg/bee)	Oral LC_{50} (µg/bee)	Toxicity Category	MRID No. Author/Year	Study Classification
Honey Bee (*Apis mellifera*)	tech.	1.3	0.14	Highly toxic	05001991 Stevenson (1978)	Core
Honey Bee (*Apis mellifera)*	tech	2.0	---	Highly toxic	00036935 Atkins *et al*. (1975)	Core
Honey Bee (*Apis mellifera*)	tech	1.1	0.11	Highly toxic	05004151 Stevenson (1968)	Core

The topical LD_{50} for alfalfa leaf-cutter bee (*Megachile pacifica* = *M. rotundata*) = 262.4 µg/g (05015678) (Lee & Brindley 1974). However, exposing leaf-cutter bees (Megachilidae), alkali bees (Halictidae), and honey bees (Apidae) to 24 hr residues from 80% WP carbaryl applied at the rate of 1 lb/acre resulted, respectively, in a 85%, 78%, and 69% mortality rate (Johansen 1972) (ID #05000837). Some carbaryl formulations can be highly toxic to bees exposed to direct application, i.e. when bees are actively visiting blooming crops or weeds. Residual toxicity varies with the crops and weather conditions.

Carbaryl can also be from moderately to highly toxic to predaceous arthropods. These include lace bugs (Nabidae) (MRID #05010807), big eyed bugs (Geocoridae: *Geocoris*) (MRID #05010807,), lady beetles (Coccinellidae: *Coccinella*, *Cryptolaemus, Hippodamia, Lindorus, Rhodolia, Stethorus*) (MRID #05013372, 05003978, 05005640), ground beetles (Carabidae: *Scarites, Pterostichus, Bembidion, Harpalus*) (MRID #05008149), hymenopterous parasitoids (*Aphytis, Metaphycus, Spalangia, Leptomastix*) (MRID #05003978, 05005640), predaceous mites (*Amblyseius, Typhlodromus*) (MRID #05004148, 05013359, 05009346), and spiders (MRID #05010807). Bee kill incidents have been reported for North Carolina, California, and Washington (#1003826-016, #1003226-021, #1005855-001, #1001611-002).

Toxicity to Freshwater Aquatic Animals

Freshwater Fish, Acute

Results of toxicity tests with freshwater fish are tabulated in Table 6. Since the LC_{50} values for the species tested are in the 0.25 - 20.0 ppm range, carbaryl can therefore range from highly to slightly toxic to freshwater fish on an acute basis. Guidelines 72-1(a) and 72-1(c) are fulfilled (MRID 40098001, 00043115).

Table 6. Summary of freshwater fish acute toxicity for technical grade carbaryl

Species	% ai	96-hour LC_{50} (ppm) (nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow Trout *(Oncorhynchus mykiss)*	99.5	1.2	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Chinook Salmon *(Oncorhynchus tshawytacha)*	99.5	2.4	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Supplemental
Bluegill Sunfish *(Lepomis macrochirus)*	99.9	14.0	Slightly Toxic	00043115 McCann *et al* (1969)	Core
Bluegill Sunfish *(Lepomis macrochirus)*	99.9	5.04	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Channel Catfish (*Ictalurus punctatus*)	99.9	7.79	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Fathead Minnow (*Pimephales promelas*)	99.5	7.7	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Black Crappie (*Pomoxis nigromaculatus*)	99.5	2.6	Moderately Toxic	40094602 Johnson & Finley (1986)	Core
Atlantic Salmon (*Salmo salar*)	99.5	0.25	Highly Toxic	40098001 Mayer & Ellersieck (1986)	Core
Brown Trout *(Salmo trutta)*	99.5	6.3	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Brook Trout (*Salvelinus fontinalis*)	99.5	3.0	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Lake Trout (*Salvelinus namaycush)*	99.5	0.69	Highly Toxic	40098001 Mayer & Ellersieck (1986)	Core
Coho Salmon (*Oncorhynchus kisutch*)	99.5	2.4	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Yellow Pearch (*Percs flavescens)*	99.5	0.35	Highly Toxic	40098001 Mayer & Ellersieck (1986)	Core
Cutthroat Trout *(Oncorhynchus clarki)*	99.5	0.97	Highly Toxic	40098001 Mayer & Ellersieck (1986)	Core
Largemouth Bass *(Micropterus salmoides)*	99.5	6.4	Moderately Toxic	40094602 Johnson & Finley (1980)	Core
Green Sunfish (*Lepomis cyanellus*)	99.5	9.5	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core
Black Bullhead *(Ictalurus melas)*	99.5	20.0	Slightly Toxic	40098001 Mayer & Ellersieck (1986)	Core
Longnose Killifish (Fundulus similis)	99.7	1.6	Moderately Toxic	40228401 Mayer (1986)	Supplemental
Carp (Cyprinus carpio)	99.5	5.3	Moderately Toxic	40098001 Mayer & Ellersieck (1986)	Core

Toxicity was determined for the typical end-use product as well, with all LC_{50} values, except one, ranging from 1.4 to 49 ppm, which indicates that carbaryl can be classified as slightly to moderately toxic to freshwater fish (Table 7). Guidelines (b) and 72-1(d) are fulfilled (MRID #s 00059202, 00042381, 00151519, 00151417, 42397901, 00124383, 00124391).

Table 7. Summary of freshwater fish acute toxicity for carbaryl (typical end-use product)

Species	% ai	96-hr LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow Trout (*Oncorhynchus mykiss*)	44	1.4	Moderately Toxic	00151417 Sousa (1985)	Core
Rainbow Trout (*Oncorhynchus mykiss*)	81.5	3.3	Moderately Toxic	42397901 Lintott (1992)	Core
Rainbow Trout (*Oncorhynchus mykiss*)	50	3.45	Moderately Toxic	00124383 McCann (1971)	Core
Rainbow Trout (*Oncorhynchus mykiss)*	50	4.5	Moderately Toxic	00124383 McCann (1971)	Core
Bluegill Sunfish (*Lepomis macrochirus*)	30	49.0	Slightly Toxic	00059202 Mc Caan (1970)	Core
Bluegill Sunfish *(Lepomis macrochirus*)	5	290.0	Practically Non-toxic	00042381 McCann (1968)	Core
Bluegill Sunfish *(Lepomis macrochirus*)	44	9.8	Moderately Toxic	00151519 Sousa (1985)	Core
Bluegill Sunfish *(Lepomis macrochirus*)	50	22.0	Slightly Toxic	00124391 McCann (1971)	Core

Freshwater Fish, Chronic

Results of the required early life-stage with fish are summarized in Table 8, show that carbaryl has high potential for chronic toxicity to freshwater fish. Exposure to 680 ppb can result in growth effects to young. The guideline requirement 72-4(a) for freshwater fish is fulfilled (TOUCARO5).

Table 8. Summary of freshwater fish life-cycle toxicity under flow-through conditions for technical grade carbaryl

Species	% ai	NOAEC/LOAC (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Fathead Minnow (*Pimephales promelas*)	99	0.21/ 0.68	Reproduction	TOUCARO5 Carlson (1972)	Core

Amphibians

According to a supplemental study with an end-use product containing 50% carbaryl (MRID 00160000), the LD_{50} for, the bullfrog (*Rana catesbeiana*) is greater than 4,000 mg/kg, or practically nontoxic.

Freshwater Invertebrates, Acute

Since the EC_{50} falls in the range of 1.7 - 26 ppb, carbaryl is categorized as very highly toxic to aquatic invertebrates on an acute basis (Table 9). Toxicity studies with the typical end-use product show that carbaryl is very highly toxic to daphnids, with an EC_{50} in the 4.29 - 13.0 ppb range (Table 10). Guideline 72-2 is fulfilled (MRID #s 40098001, 42397902, 42397903).

Table 9. Summary of freshwater invertebrate acute toxicity for technical grade carbaryl

Species/Static or Flow-through	% ai	48-hour EC50 (ppb) (nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Water flea (*Daphnia magna*)	99.5	5.6	Very Highly Toxic	40098001 Mayer & Ellersieck (1986)	Core
Stonefly (*Classenia sabulosa*)	99.5	96hr LC50=5.6	Very Highly Toxic	40098001 Mayer & Ellersieck (1986)	Supplemental
Stonefly (*Isogenus sp.*)	99.5	96hr LC50=3.6	Very Highly Toxic	40098001 Mayer & Ellersieck (1986)	Supplemental
Stonefly (*Pteronarcella badia*)	99.5	96hr LC50=1.7	Very Highly Toxic	40098001 Mayer & Ellersieck (1986)	Supplemental
Scud (*Gammarus fasciatus*)	99.5	96hr EC50=26	Very Highly Toxic	40098001 Mayer & Ellersieck (1986)	Core

Table 10. Acute toxicity to invertebrates (TEP)

Species	% ai	48-hour EC50 (ppb)	Toxicity category	MRID No. Author/Year	Study Classification
Water flea (*Daphnia magna*)	49.0%	7.1	Very highly toxic	00150538 Nicholson and Surprenant (1985)	Supplemental
Water flea (*Daphnia magna*)	43.9%	13.0	Very highly toxic	00150540 Nicholson and Surprenant (1985)	Supplemental
Water flea (*Daphnia magna*)	47.3%	4.29	Very highly toxic	42432401 Lintott (1992)	Supplemental
Water flea (*Daphnia magna*)	43.7%	6.66	Very highly toxic	42397902 Lintott (1992)	Core

Water flea (*Daphnia magna*)	81.5%	7.2	Very highly toxic	42397903 Lintott (1992)	Core

Freshwater Invertebrate, Chronic

A 21-day toxicity study preformed with the water flea estimated a NOAEC and a LOAEC of 1.5 ppb and 3.3 ppb, respectively, based on affected reproduction (Table 11). Guideline 72-4(b) for freshwater invertebrates is fulfilled (MRID 00150901).

Table 11. Summary of freshwater aquatic invertebrate life-cycle toxicity for technical grade carbaryl

Species	% ai	21-day NOAEC/ LOAEC (ppb)	Endpoints Affected	MRID No. Author/Year	Study Classification
Water flea *(Daphnia magna)*	99.0%	1.5/3.3	Reproduction	00150901 Surprenant (1985)	Core

Toxicity to Estuarine and Marine Animals

Estuarine/Marine Fish, Acute

Since the minnow LC_{50} is 2.6 ppm (Table 12), carbaryl is categorized as moderately toxic to estuarine/marine fish on an acute basis. The guideline 72-3(a) is fulfilled (MRID 42372801).

Table 12. Summary of estuarine/marine fish acute toxicity for technical grade carbaryl

Species/Static	% ai	96-hour LC50 (ppm) (nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Sheepshead Minnow *(Cyprinodon variegatus)*	99	2.2	Moderately Toxic	00150539 Sousa and Surprenant (1985)	Supplemental
Sheepshead Minnow *(Cyprinodon variegatus)*	99.7%	2.6	Moderately Toxicc	42372801 Lintott (1992)	Core

Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity test using the TGAI is required for carbaryl because the end-use product is expected to be transported to this environment from the intended use site. Carbaryl is registered for ghost and mud shrimp control in oyster beds in Washington and has the potential to affect nontarget fish and invertebrates outside the application sites. In addition, the pesticide uses are such that its presence in water is likely to be continuous (multiple applications), and chronic concerns have been noted for freshwater fish and marine and freshwater. At this point, the guideline 72-4(a) for estuarine/marine fish is not fulfilled.

Estuarine and Marine Invertebrates, Acute

As shown in Table 13, the 96-hour mysid shrimp LC_{50} for technical carbaryl falls is 5.7 ppb (MRID 42343401). Thus, this chemical is categorized as very highly toxic to estuarine/ marine shrimp species on an acute basis. By contrast, carbaryl is moderately toxicity to the oyster (LC_{50} = 2.7 ppm, MRID 00148221). Guidelines 72-3(b) and 72-3(c) are fulfilled.

Table 13. Summary of estuarine/marine invertebrate acute toxicity for technical grade carbaryl

Species	% ai.	48-hour LC50 (ppb)	Toxicity Category	MRID No. Author/Year	Study Classification
Brown Shrimp (*Penaeus aztecus*)	99.7	1.5	Very Highly Toxic	40228401 Mayer (1986)	Supplemental
Mysid (*Mysidopsis bahia*)	99	96 hr LC_{50} = 6.7	Very Highly Toxic	00150544 Hoberg and Surprenant (1985)	Supplemental
Mysid (*Mysidopsis bahia*)	99.7	96 hr LC_{50} = 5.7	Very Highly Toxic	42343401 Lintott (1992)	Core
Glass Shrimp (*Palaemonetes kadiakensis*)	99.5	5.6	Very Highly Toxic	40098001 Mayer & Ellersieck (1986)	Supplemental
Grass Shrimp (*Palaemonetes pugio*)	99.7	28	Very Highly Toxic	40228401 Mayer (1986)	Supplemental
Pink Shrimp (*Penaeus duorarum*)	99.7	32	Very Highly Toxic	40228401 Mayer (1986)	Supplemental
Eastern Oyster (*Crassostrea virginica*)	99.7	96 hr LC_{50}>2	Very Highly Toxic	40228401 Mayer (1986)	Core
Eastern Oyster (*Crassostrea virginica*)	99	2700	Moderately Toxic	00148221 Surprenant, *et al.* (1985)	Core
Blue Crab (*Callinectes sapidus*)	99.7	320	Highly Toxic	40228401 Mayer (1986)	Supplemental
Fairy Shrimp	95.3%	170	Highly toxic	40094602 Mayer (1986)	Supplemental
Eastern Oyster (*Crassostria virginica*)	95.0%	>1,000	Moderately toxic	40228401 Mayer (1986)	Supplemental

Results of toxicity testing using the typical end-use product are summarized in Table 14. Carbaryl TEPs are highly toxic to mysids, LC_{50} values ranging from 9.3 to 20.2 ppb (MRID #s 42397904, 42565601, and 42343402), and slightly toxic to oysters (LC_{50} = 23.6 ppm, MRID 42597301). Guidelines 72-3(e) and 72-3(f) are fulfilled.

Table 14. Summary of estuarine/marine invertebrate acute toxicity for TEP

Species	% ai.	48-hour LC50 (ppb)	Toxicity Category	MRID No. Author/Year	Study Classification
Mysid (*Mysidopsis bahia*)	81.5	9.6	Very Highly Toxic	42397904 Lintott (1992)	Core
Mysid (*Mysidopsis bahia*)	81.5	9.3	Very Highly Toxic	42565601 McElwee and Lintott (1992)	Core
Mysid (*Mysidopsis bahia*)	43.7%	96 hr LC_{50} = 20.2	Very Highly Toxic	42343402 Lintott (1992)	Core
Eastern Oyster (*Crassostrea virginica*)	43.3%	96 hr LC_{50} = 23,600	Slightly Toxic	42597301 Lintott (1992)	Supplemental

Estuarine and Marine Invertebrate, Chronic

There are no available chronic toxicity data for estuarine/marine invertebrates. The guideline 72-4(b) for estuarine/marine invertebrates is no fulfilled.

1-Naphthol Toxicity to Aquatic Organisms

The major metabolite of carbaryl degradation by abiotic and microbially mediated processes is 1-naphthol. As summarized in Table 15, 1-naphthol is categorized as moderately to highly toxic to aquatic organisms on an acute basis, LC_{50} values ranging from 0.75 to 1.6 ppm for freshwater fish, from 1.2 to 1.8 ppm for estuarine/marine fish, from 0.70 to 0.73 ppm for freshwater invertebrates, and from 0.21 to 2.5 ppm for estuarine/marine invertebrates.

Terrestrial Plants

Toxicity testing of terrestrial plants is required for non-herbicide pesticides when the label warns that nontarget plants could be adversely affected. Carbaryl can be used as a fruit thinning agent on apples and pears. However, the label cautions that the product may result in fruit deformity under certain environmental conditions. The label also cautions that application to wet foliage or during periods of high humidity may cause injury to tender foliage. Label language indicates that carbaryl should not be used on Boston ivy, Virginia creeper, and maidenhair fern due to potential injury. Incidents have also been recorded for vegetable crops (tomatoes, potatoes, cabbage, broccoli, pumpkin, squash, cucumbers) in New York and Pennsylvania (#1009262-128; #1009305-001). Guideline 122-1 is not fulfilled.

Table 15 Summary of aquatic organisms acute toxicity for carbaryl degradate alpha naphthol

Species	96-hour LC_{50} (ppm) (nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow Trout (Oncorhynchus mykiss)	1.4	Moderately Toxic	40955204 Surprenant (1988)	Core
Rainbow Trout *(Oncorhynchus mykiss)*	1.6	Moderately Toxic	00164307 Surprenant (1986)	Supplemental
Bluegill Sunfish *(Lepomis macrochirus)*	0.76	Highly Toxic	40955203 Surprenant (1988)	Core
Bluegill Sunfish *(Lepomis macrochirus)*	0.75	Highly Toxic	00164305 Surprenant (1986)	Supplemental
Sheepshead Minnow *(Cyprinodon variegatus)*	1.2	Moderately Toxic	40955201 Surprenant (1988)	Core
Sheepshead Minnow *(Cyprinodon variegatus)*	1.8	Moderately Toxic	00164306 Surprenant (1986)	Supplemental
Waterflea (*Daphnia magna*)	48 hr LC_{50} = 0.73	Highly Toxic	40955205 Surprenant (1988)	Core
Waterflea (*Daphnia magna*)	48 hr LC_{50} = 0.70	Highly Toxic	00164310 Surprenant (1986)	Supplemental
Mysid *(Mysidopsis bahia)*	0.21	Highly Toxic	40955202 Surprenant (1988)	Core
Mysid *(Mysidopsis bahia)*	0.20	Highly Toxic	00164309 Surprenant (1986)	Supplemental
Eastern Oyster *(Crassostrea virginica)*	48 hr LC_{50} = 2.1	Moderately Toxic	00164308 Surprenant (1986)	Core

Aquatic Plants

Aquatic plant testing is recommended for all pesticides having outdoor uses (Keehner. July 1999). The tests are performed on species from a cross-section of the nontarget aquatic plant population. The preferred test species are duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), freshwater blue-green algae (*Anabaena flos-aquae*), freshwater green alga (*Selenastrum capricornutum*), and a freshwater diatom. Toxicity testing for aquatic plant species is required for carbaryl because of its registered forestry uses. Data based on a single available core toxicity study with the green alga *Pseudokirchneria subcapitata* (formerly *Selenastrum capricornutum*) indicates that the LC_{50} and NOAEC are, respectively, 1.1 ppm and 0.37 ppm (MRID #42372802). Guideline 122-2 is not fulfilled.

Appendix D: ELL-FATE - Description and example worksheet

ELL-Fate Version 1.2
Developed by Laurence Libelo. February, 1999

This spreadsheet based model calculates the decay of a chemical applied to foliar surfaces for single or multiple applications. It uses the same principle as the batch code models FATE and TERREEC for calculating terrestrial estimates exposure (TEEC) concentrations on plant surfaces following application.

A first order decay assumption is used to determine the concentration at each day after initial application based on the concentration resulting from the initial and additional applications. The decay is calculated by from the first order rate equation:

$$C_T = C_i e^{-kT}$$

or in integrated form:

$$\ln (C_T/C_i) = kT$$

Where

C_T = concentration at time T
Ci = initial concentration
k = reaction rate constant
T = time

The program calculates concentration on each type of surface on a daily interval for one year. The maximum concentration during the year and the average concentration during the first 56 days are calculated.

The inputs used to calculate the amount of the chemical present are in highlighted in yellow on the spread sheet. Outputs are in blue. The inputs required are:

Application Rate:
Half-life:
Frequency of Application:
Maximum # Application per year:

The calculated concentrations are used to calculate Avian and Mammalian RQ values. The maximum calculated concentration is divided by user input values of Chronic No Observable Adverse Effects Level and acute LC50 to give RQs for each type of plant surface.

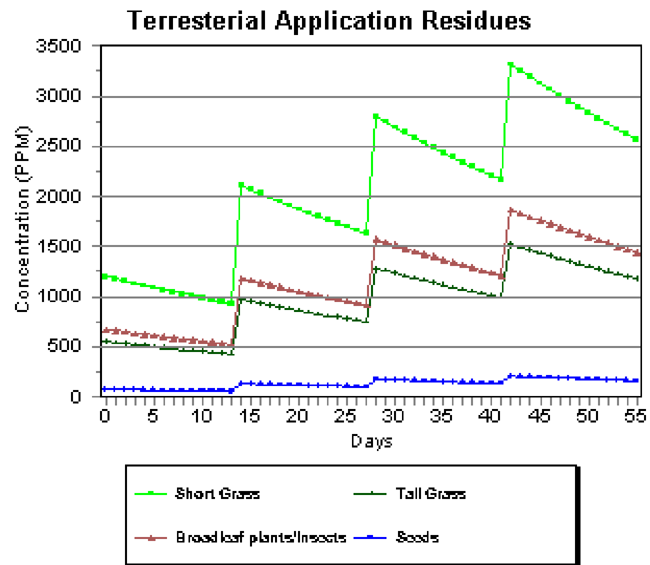
The rat LC 50 is calculated by dividing the mammalian LD 50 by 0.05 (to correct for actual food consumption)

For 15g, 35g and 1000 g mammals the RQ values are calculated by dividing the maximum concentration for each surface by the LD 50 or NOAEL corrected for consumption (0.95, 0.66 and .15 body wt. for herbivores and) insectivores and 0.21, 0.15 and 0.3 body wt. for granivore) The number of days that the input value of Chronic No Observable Adverse Effects Level and acute LC50 are exceeded in the first 56 days is calculated by comparing the input value to the calculated concentration.

A graph of concentration on each plant surface vs time is plotted and a "level of concern" line can be added at a user specified level.

The maximum single application which can be applied and not exceed the toxicity input values if calculated by dividing the input value by the Kenaga maximum concentration for Short Grass (240).

Chemical Name:	Carbaryl	
Use	Citrus	
Formulation		



Inputs

Application Rate	5	lbs a.i./acre
Half-life	35	days
Frequency of Application	14	days
Maximum # Apps./Year	4	

Outputs

	Maximum Concentration (PPM)	56 day Average Concentration (PPM)
Short Grass	**3320.98**	**2079.15**
Tall Grass	**1522.12**	**952.94**
Broadleaf plants/Insects	**1868.05**	**1169.52**
Seeds	**207.56**	**129.95**

Avian

		# days Exceeded on short grass (in first 56)
Acute LC_{50} (ppm)	5000	0
Chronic NOAEC (ppm)	300	56

	Acute RQ	Chronic RQ (Max. res. mult. apps.)
Short Grass	**0.66**	**11.07**
Tall Grass	**0.30**	**5.07**
Broadleaf plants/Insects	**0.37**	**6.23**
Seeds	**0.04**	**0.69**

Max Single Application which does NOT exceed		
Avian Acute	20.833	(lb a.i.)
Avian Chronic	1.250	
Mammalian Acute	8.36	
Mammalian Chronic	0.33	

Mammalian

		# days Exceeded on short grass (in first 56)
Acute LD_{50} (mg/kg)	301	56
Chronic NOAEL (mg/kg)	80	56

Rat Calculated LC_{50} (ppm): 6020

	15 g mammal Acute RQ (mult. apps)	35 g mammal Acute RQ (mult. apps)	1000 g mammal Acute RQ (mult. apps)	Rat Acute Dietary RQ	Rat Chronic Dietary RQ
Short Grass	**10.48**	**7.28**	**1.65**	**0.55**	**41.51**
Broadleaf plants/ insects	**4.80**	**3.34**	**0.76**	**0.25**	**19.03**
Large Insects	**5.90**	**4.10**	**0.93**	**0.31**	**23.35**
Seeds (granivore)	**0.14**	**0.10**	**0.02**	**0.03**	**2.59**

Appendix E: Examples of PRZM Standard Pond Input Files

```
*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted 3/30/2000 ***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00 (standard pond on 7/14/2000)
*** Manning's N values for cornstalk residue, fallow surface, 1 ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami; brookston; glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063; Ground spray: 0.064 ***
*** Standard Pond Spray Drift:  Aerial = 0.05; Ground spray = 0.01
*** Application efficiency: aerial = 0.95;   ground spray = 0.99 ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
       4
*** - RECORD 7 ***
    0.37    0.43    0.50    10.0   5.80       3    6.00   354.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00  100.00
*** - RECORD 9A ***
       1       3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
  160558  260958  111058       1
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
"average" Application: ground spray - 2 apps @ 3.4 lb a.i./acre
*** Application by ground spray - 8 apps @ 2 lb a.i./acre
*** - RECORD 13 ***
     108       1       0       0
*** - RECORD - 15 ***
```

```
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days; AnSM T1/2 = 24 days
*** - RECORD 16 ***
  300448  0 2 0.00  1.12 0.95 0.05
  140548  0 2 0.00  1.12 0.95 0.05
  280548  0 2 0.00  1.12 0.95 0.05
  300449  0 2 0.00  1.12 0.95 0.05
  140549  0 2 0.00  1.12 0.95 0.05
  280549  0 2 0.00  1.12 0.95 0.05
  300450  0 2 0.00  1.12 0.95 0.05
  140550  0 2 0.00  1.12 0.95 0.05
  280550  0 2 0.00  1.12 0.95 0.05
  300451  0 2 0.00  1.12 0.95 0.05
  140551  0 2 0.00  1.12 0.95 0.05
  280551  0 2 0.00  1.12 0.95 0.05
  300452  0 2 0.00  1.12 0.95 0.05
  140552  0 2 0.00  1.12 0.95 0.05
  280552  0 2 0.00  1.12 0.95 0.05
  300453  0 2 0.00  1.12 0.95 0.05
  140553  0 2 0.00  1.12 0.95 0.05
  280553  0 2 0.00  1.12 0.95 0.05
  300454  0 2 0.00  1.12 0.95 0.05
  140554  0 2 0.00  1.12 0.95 0.05
  280554  0 2 0.00  1.12 0.95 0.05
  300455  0 2 0.00  1.12 0.95 0.05
  140555  0 2 0.00  1.12 0.95 0.05
  280555  0 2 0.00  1.12 0.95 0.05
  300456  0 2 0.00  1.12 0.95 0.05
  140556  0 2 0.00  1.12 0.95 0.05
  280556  0 2 0.00  1.12 0.95 0.05
  300457  0 2 0.00  1.12 0.95 0.05
  140557  0 2 0.00  1.12 0.95 0.05
  280557  0 2 0.00  1.12 0.95 0.05
  300458  0 2 0.00  1.12 0.95 0.05
  140558  0 2 0.00  1.12 0.95 0.05
  280558  0 2 0.00  1.12 0.95 0.05
  300459  0 2 0.00  1.12 0.95 0.05
  140559  0 2 0.00  1.12 0.95 0.05
  280559  0 2 0.00  1.12 0.95 0.05
  300460  0 2 0.00  1.12 0.95 0.05
  140560  0 2 0.00  1.12 0.95 0.05
  280560  0 2 0.00  1.12 0.95 0.05
  300461  0 2 0.00  1.12 0.95 0.05
  140561  0 2 0.00  1.12 0.95 0.05
  280561  0 2 0.00  1.12 0.95 0.05
  300462  0 2 0.00  1.12 0.95 0.05
  140562  0 2 0.00  1.12 0.95 0.05
  280562  0 2 0.00  1.12 0.95 0.05
  300463  0 2 0.00  1.12 0.95 0.05
  140563  0 2 0.00  1.12 0.95 0.05
  280563  0 2 0.00  1.12 0.95 0.05
  300464  0 2 0.00  1.12 0.95 0.05
  140564  0 2 0.00  1.12 0.95 0.05
  280564  0 2 0.00  1.12 0.95 0.05
  300465  0 2 0.00  1.12 0.95 0.05
  140565  0 2 0.00  1.12 0.95 0.05
  280565  0 2 0.00  1.12 0.95 0.05
  300466  0 2 0.00  1.12 0.95 0.05
  140566  0 2 0.00  1.12 0.95 0.05
  280566  0 2 0.00  1.12 0.95 0.05
  300467  0 2 0.00  1.12 0.95 0.05
  140567  0 2 0.00  1.12 0.95 0.05
  280567  0 2 0.00  1.12 0.95 0.05
  300468  0 2 0.00  1.12 0.95 0.05
  140568  0 2 0.00  1.12 0.95 0.05
  280568  0 2 0.00  1.12 0.95 0.05
  300469  0 2 0.00  1.12 0.95 0.05
  140569  0 2 0.00  1.12 0.95 0.05
  280569  0 2 0.00  1.12 0.95 0.05
  300470  0 2 0.00  1.12 0.95 0.05
  140570  0 2 0.00  1.12 0.95 0.05
  280570  0 2 0.00  1.12 0.95 0.05
  300471  0 2 0.00  1.12 0.95 0.05
  140571  0 2 0.00  1.12 0.95 0.05
  280571  0 2 0.00  1.12 0.95 0.05
  300472  0 2 0.00  1.12 0.95 0.05
  140572  0 2 0.00  1.12 0.95 0.05
  280572  0 2 0.00  1.12 0.95 0.05
  300473  0 2 0.00  1.12 0.95 0.05
  140573  0 2 0.00  1.12 0.95 0.05
  280573  0 2 0.00  1.12 0.95 0.05
```

```
  300474  0 2 0.00  1.12 0.95 0.05
  140574  0 2 0.00  1.12 0.95 0.05
  280574  0 2 0.00  1.12 0.95 0.05
  300475  0 2 0.00  1.12 0.95 0.05
  140575  0 2 0.00  1.12 0.95 0.05
  280575  0 2 0.00  1.12 0.95 0.05
  300476  0 2 0.00  1.12 0.95 0.05
  140576  0 2 0.00  1.12 0.95 0.05
  280576  0 2 0.00  1.12 0.95 0.05
  300477  0 2 0.00  1.12 0.95 0.05
  140577  0 2 0.00  1.12 0.95 0.05
  280577  0 2 0.00  1.12 0.95 0.05
  300478  0 2 0.00  1.12 0.95 0.05
  140578  0 2 0.00  1.12 0.95 0.05
  280578  0 2 0.00  1.12 0.95 0.05
  300479  0 2 0.00  1.12 0.95 0.05
  140579  0 2 0.00  1.12 0.95 0.05
  280579  0 2 0.00  1.12 0.95 0.05
  300480  0 2 0.00  1.12 0.95 0.05
  140580  0 2 0.00  1.12 0.95 0.05
  280580  0 2 0.00  1.12 0.95 0.05
  300481  0 2 0.00  1.12 0.95 0.05
  140581  0 2 0.00  1.12 0.95 0.05
  280581  0 2 0.00  1.12 0.95 0.05
  300482  0 2 0.00  1.12 0.95 0.05
  140582  0 2 0.00  1.12 0.95 0.05
  280582  0 2 0.00  1.12 0.95 0.05
  300483  0 2 0.00  1.12 0.95 0.05
  140583  0 2 0.00  1.12 0.95 0.05
  280583  0 2 0.00  1.12 0.95 0.05

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
       0
            YEAR      10             YEAR      10             YEAR      10   1
       1
       1  -----
       7    YEAR
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5

*** PRZM3 Input File for INDEX RESERVOIR, IROHCORN1.inp converted 3/30/2000 ***
*** Modeler: S. Abel ***
*** Modified for CARBARYL by Laurence Libelo, 6/20/00 (standard pond on 7/14/2000)
*** *** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE VALUES on 2/23/01 ***
*** Manning's N values for cornstalk residue, fallow surface, 1 ton/acre ***
*** Cardington silt loam is not one of the benchmark soils ***
*** Benchmark soils include: blount; crosby; pewamo; miami; brookston; glynwood ***
*** miamian; morley; bennington; and fincastle ***
*** IR Spray Drift: Aerial: 0.16; Orchard air blast: 0.063; Ground spray: 0.064 ***
*** Standard Pond Spray Drift:  Aerial = 0.05; Ground spray = 0.01
*** Application efficiency: aerial = 0.95;   ground spray = 0.99 ***
*** PCA for corn = 0.46 ***
CARBARYL
Location: OH Crop: corn    MLRA 111
*** - RECORD 3  ***
    0.72    0.30       0   15.00       1       3
*** - RECORED 4 ***
```

```
       4
*** - RECORD 7 ***
    0.37    0.43    0.50    10.0   5.80       3    6.00   354.0
*** - RECORD 8 ***
       1
*** - RECORD 9 ***
       1    0.25   90.00  100.00       3  91  85  88    0.00  100.00
*** - RECORD 9A ***
       1       3
*** - RECORD 9B,C,D
0101 1605 1110
0.50 0.25 0.30
0.02 0.02 0.02
*** - RECORD 10 ***
      36
*** - RECORD 11 *
  160548  260948  111048       1
  160549  260949  111049       1
  160550  260950  111050       1
  160551  260951  111051       1
  160552  260952  111052       1
  160553  260953  111053       1
  160554  260954  111054       1
  160555  260955  111055       1
  160556  260956  111056       1
  160557  260957  111057       1
  160558  260958  111058       1
  160559  260959  111059       1
  160560  260960  111060       1
  160561  260961  111061       1
  160562  260962  111062       1
  160563  260963  111063       1
  160564  260964  111064       1
  160565  260965  111065       1
  160566  260966  111066       1
  160567  260967  111067       1
  160568  260968  111068       1
  160569  260969  111069       1
  160570  260970  111070       1
  160571  260971  111071       1
  160572  260972  111072       1
  160573  260973  111073       1
  160574  260974  111074       1
  160575  260975  111075       1
  160576  260976  111076       1
  160577  260977  111077       1
  160578  260978  111078       1
  160579  260979  111079       1
  160580  260980  111080       1
  160581  260981  111081       1
  160582  260982  111082       1
  160583  260983  111083       1
*** - RECORD 12 ***
Application by ground spray Rate = "average" from QUA memo (July 21, 1998) - 2 apps @ 1 lb a.i./acre
*** Application by ground spray - 8 apps @ 2 lb a.i./acre
*** - RECORD 13 ***
      72       1       0       0
*** - RECORD - 15 ***
Carbaryl Chemical Kd: 3.0 (Silt Loam Soil); ASM T1/2 = 12 days; AnSM T1/2 = 24 days
*** - RECORD 16 ***
  300448  0 2 0.00  1.68 0.95 0.05
  140548  0 2 0.00  1.68 0.95 0.05
  300449  0 2 0.00  1.68 0.95 0.05
  140549  0 2 0.00  1.68 0.95 0.05
  300450  0 2 0.00  1.68 0.95 0.05
  140550  0 2 0.00  1.68 0.95 0.05
  300451  0 2 0.00  1.68 0.95 0.05
  140551  0 2 0.00  1.68 0.95 0.05
  300452  0 2 0.00  1.68 0.95 0.05
  140552  0 2 0.00  1.68 0.95 0.05
  300453  0 2 0.00  1.68 0.95 0.05
  140553  0 2 0.00  1.68 0.95 0.05
  300454  0 2 0.00  1.68 0.95 0.05
  140554  0 2 0.00  1.68 0.95 0.05
  300455  0 2 0.00  1.68 0.95 0.05
  140555  0 2 0.00  1.68 0.95 0.05
```

```
  300456  0 2 0.00  1.68 0.95 0.05
  140556  0 2 0.00  1.68 0.95 0.05
  300457  0 2 0.00  1.68 0.95 0.05
  140557  0 2 0.00  1.68 0.95 0.05
  300458  0 2 0.00  1.68 0.95 0.05
  140558  0 2 0.00  1.68 0.95 0.05
  300459  0 2 0.00  1.68 0.95 0.05
  140559  0 2 0.00  1.68 0.95 0.05
  300460  0 2 0.00  1.68 0.95 0.05
  140560  0 2 0.00  1.68 0.95 0.05
  300461  0 2 0.00  1.68 0.95 0.05
  140561  0 2 0.00  1.68 0.95 0.05
  300462  0 2 0.00  1.68 0.95 0.05
  140562  0 2 0.00  1.68 0.95 0.05
  300463  0 2 0.00  1.68 0.95 0.05
  140563  0 2 0.00  1.68 0.95 0.05
  300464  0 2 0.00  1.68 0.95 0.05
  140564  0 2 0.00  1.68 0.95 0.05
  300465  0 2 0.00  1.68 0.95 0.05
  140565  0 2 0.00  1.68 0.95 0.05
  300466  0 2 0.00  1.68 0.95 0.05
  140566  0 2 0.00  1.68 0.95 0.05
  300467  0 2 0.00  1.68 0.95 0.05
  140567  0 2 0.00  1.68 0.95 0.05
  300468  0 2 0.00  1.68 0.95 0.05
  140568  0 2 0.00  1.68 0.95 0.05
  300469  0 2 0.00  1.68 0.95 0.05
  140569  0 2 0.00  1.68 0.95 0.05
  300470  0 2 0.00  1.68 0.95 0.05
  140570  0 2 0.00  1.68 0.95 0.05
  300471  0 2 0.00  1.68 0.95 0.05
  140571  0 2 0.00  1.68 0.95 0.05
  300472  0 2 0.00  1.68 0.95 0.05
  140572  0 2 0.00  1.68 0.95 0.05
  300473  0 2 0.00  1.68 0.95 0.05
  140573  0 2 0.00  1.68 0.95 0.05
  300474  0 2 0.00  1.68 0.95 0.05
  140574  0 2 0.00  1.68 0.95 0.05
  300475  0 2 0.00  1.68 0.95 0.05
  140575  0 2 0.00  1.68 0.95 0.05
  300476  0 2 0.00  1.68 0.95 0.05
  140576  0 2 0.00  1.68 0.95 0.05
  300477  0 2 0.00  1.68 0.95 0.05
  140577  0 2 0.00  1.68 0.95 0.05
  300478  0 2 0.00  1.68 0.95 0.05
  140578  0 2 0.00  1.68 0.95 0.05
  300479  0 2 0.00  1.68 0.95 0.05
  140579  0 2 0.00  1.68 0.95 0.05
  300480  0 2 0.00  1.68 0.95 0.05
  140580  0 2 0.00  1.68 0.95 0.05
  300481  0 2 0.00  1.68 0.95 0.05
  140581  0 2 0.00  1.68 0.95 0.05
  300482  0 2 0.00  1.68 0.95 0.05
  140582  0 2 0.00  1.68 0.95 0.05
  300483  0 2 0.00  1.68 0.95 0.05
  140583  0 2 0.00  1.68 0.95 0.05

*** - Record 17 ***
    0.0     3      0
*** - RECORD 18 ***
    0.0     0.0    0.00
*** - RECORD 19 ***
Soil Series: Cardington silt loam; Hydrogic Group C
*** - RECORD 20 ***
  100.00           0   0   0   0   0   0   0   0   0
*** - RECORD 26 ***
    0.00    0.00   00.00
*** - RECORD 33 ***
       2
*** RECORD 34,36,37
       1  22.000   1.600   0.294   0.000   0.000   0.000
          0.058  0.058   0.000
           0.200   0.294   0.086   1.160    3.0
       2  78.000   1.650   0.147   0.000   0.000   0.000
          0.029  0.029   0.000
           1.000   0.147   0.087   0.174    3.0
```

```
    0
         YEAR       10            YEAR       10            YEAR       10   1
    1
    1  -----
    7    YEAR
PRCP     TSER   0   0
RUNF     TSER   0   0
INFL     TSER   1   1
ESLS     TSER   0   0   1.E3
RFLX     TSER   0   0   1.E5
EFLX     TSER   0   0   1.E5
RZFX     TSER   0   0   1.E5
```

```
*** PRZM 3.1 Input Data File; ORAPPLEX.INP; Modified April 5, 1998 ***
*** Modified for Carbaryl by Laurence Libelo, 6/21/00 ***
*** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE VALUES on 2/23/01 ***
*** Crops simulated: Apples, Crabapples, and Quince ***
*** Location Washington County, Oregon; Meadow/Orchard Scenario; MLRA: A2 ***
*** Manning's N: Assume sparse grass under mature trees (ca. 20 feet) ***
*** Temperature data read ***
*** This file is for scenario standardization; Reference chemical is Atrazine ***
*** See ORAPPLEX.wpd for scenario details ***
Carbaryl
Cornelius silt loam, 15% slope, Hydrologic Group: C
   0.740   0.150       2  17.000       1       3
     9.2    10.3    11.8    13.6   15.30   15.3
    14.2    12.5    10.9     9.4     8.6     9.1
       4
    0.43    3.30     1.0    10.0     5.4       2   15.00   354.0
       1
       1    0.25    17.0 100.000       3  91  71  71                 0.0     600
       1       3
0103  0105  0112
0.01  0.01  0.01
0.015 0.015 0.015
      36
  010448  150548  151248       1
  010449  150549  151249       1
  010450  150550  151250       1
  010451  150551  151251       1
  010452  150552  151252       1
  010453  150553  151253       1
  010454  150554  151254       1
  010455  150555  151255       1
  010456  150556  151256       1
  010457  150557  151257       1
  010458  150558  151258       1
  010459  150559  151259       1
  010460  150560  151260       1
  010461  150561  151261       1
  010462  150562  151262       1
  010463  150563  151263       1
  010464  150564  151264       1
  010465  150565  151265       1
  010466  150566  151266       1
  010467  150567  151267       1
  010468  150568  151268       1
  010469  150569  151269       1
  010470  150570  151270       1
  010471  150571  151271       1
  010472  150572  151272       1
  010473  150573  151273       1
  010474  150574  151274       1
  010475  150575  151275       1
  010476  150576  151276       1
  010477  150577  151277       1
  010478  150578  151278       1
  010479  150579  151279       1
  010480  150580  151280       1
  010481  150581  151281       1
  010482  150582  151282       1
  010483  150583  151283       1
The label max used (5 apps of 2 lb a.i./acre (3.3 kg/ha))
*** Aerial Application: , Aerial @ 95% eff. w/5% drift
     180       1       0       0
Chemical Kd: 3.0 (silt Loam soil); AeSM: T1/2: 12 days; AnSM: T1/2 = 24 days
*** Record 16: Application information; set specific to carbaryl ***
  300448  0 2 0.00  2.24 0.95 0.05
  140548  0 2 0.00  2.24 0.95 0.05
  280548  0 2 0.00  2.24 0.95 0.05
  110648  0 2 0.00  2.24 0.95 0.05
  250648  0 2 0.00  2.24 0.95 0.05
  300449  0 2 0.00  2.24 0.95 0.05
  140549  0 2 0.00  2.24 0.95 0.05
  280549  0 2 0.00  2.24 0.95 0.05
  110649  0 2 0.00  2.24 0.95 0.05
  250649  0 2 0.00  2.24 0.95 0.05
  300450  0 2 0.00  2.24 0.95 0.05
  140550  0 2 0.00  2.24 0.95 0.05
```

280550	0	2	0.00	2.24	0.95	0.05
110650	0	2	0.00	2.24	0.95	0.05
250650	0	2	0.00	2.24	0.95	0.05
300451	0	2	0.00	2.24	0.95	0.05
140551	0	2	0.00	2.24	0.95	0.05
280551	0	2	0.00	2.24	0.95	0.05
110651	0	2	0.00	2.24	0.95	0.05
250651	0	2	0.00	2.24	0.95	0.05
300452	0	2	0.00	2.24	0.95	0.05
140552	0	2	0.00	2.24	0.95	0.05
280552	0	2	0.00	2.24	0.95	0.05
110652	0	2	0.00	2.24	0.95	0.05
250652	0	2	0.00	2.24	0.95	0.05
300453	0	2	0.00	2.24	0.95	0.05
140553	0	2	0.00	2.24	0.95	0.05
280553	0	2	0.00	2.24	0.95	0.05
110653	0	2	0.00	2.24	0.95	0.05
250653	0	2	0.00	2.24	0.95	0.05
300454	0	2	0.00	2.24	0.95	0.05
140554	0	2	0.00	2.24	0.95	0.05
280554	0	2	0.00	2.24	0.95	0.05
110654	0	2	0.00	2.24	0.95	0.05
250654	0	2	0.00	2.24	0.95	0.05
300455	0	2	0.00	2.24	0.95	0.05
140555	0	2	0.00	2.24	0.95	0.05
280555	0	2	0.00	2.24	0.95	0.05
110655	0	2	0.00	2.24	0.95	0.05
250655	0	2	0.00	2.24	0.95	0.05
300456	0	2	0.00	2.24	0.95	0.05
140556	0	2	0.00	2.24	0.95	0.05
280556	0	2	0.00	2.24	0.95	0.05
110656	0	2	0.00	2.24	0.95	0.05
250656	0	2	0.00	2.24	0.95	0.05
300457	0	2	0.00	2.24	0.95	0.05
140557	0	2	0.00	2.24	0.95	0.05
280557	0	2	0.00	2.24	0.95	0.05
110657	0	2	0.00	2.24	0.95	0.05
250657	0	2	0.00	2.24	0.95	0.05
300458	0	2	0.00	2.24	0.95	0.05
140558	0	2	0.00	2.24	0.95	0.05
280558	0	2	0.00	2.24	0.95	0.05
110658	0	2	0.00	2.24	0.95	0.05
250658	0	2	0.00	2.24	0.95	0.05
300459	0	2	0.00	2.24	0.95	0.05
140559	0	2	0.00	2.24	0.95	0.05
280559	0	2	0.00	2.24	0.95	0.05
110659	0	2	0.00	2.24	0.95	0.05
250659	0	2	0.00	2.24	0.95	0.05
300460	0	2	0.00	2.24	0.95	0.05
140560	0	2	0.00	2.24	0.95	0.05
280560	0	2	0.00	2.24	0.95	0.05
110660	0	2	0.00	2.24	0.95	0.05
250660	0	2	0.00	2.24	0.95	0.05
300461	0	2	0.00	2.24	0.95	0.05
140561	0	2	0.00	2.24	0.95	0.05
280561	0	2	0.00	2.24	0.95	0.05
110661	0	2	0.00	2.24	0.95	0.05
250661	0	2	0.00	2.24	0.95	0.05
300462	0	2	0.00	2.24	0.95	0.05
140562	0	2	0.00	2.24	0.95	0.05
280562	0	2	0.00	2.24	0.95	0.05
110662	0	2	0.00	2.24	0.95	0.05
250662	0	2	0.00	2.24	0.95	0.05
300463	0	2	0.00	2.24	0.95	0.05
140563	0	2	0.00	2.24	0.95	0.05
280563	0	2	0.00	2.24	0.95	0.05
110663	0	2	0.00	2.24	0.95	0.05
250663	0	2	0.00	2.24	0.95	0.05
300464	0	2	0.00	2.24	0.95	0.05
140564	0	2	0.00	2.24	0.95	0.05
280564	0	2	0.00	2.24	0.95	0.05
110664	0	2	0.00	2.24	0.95	0.05
250664	0	2	0.00	2.24	0.95	0.05
300465	0	2	0.00	2.24	0.95	0.05
140565	0	2	0.00	2.24	0.95	0.05
280565	0	2	0.00	2.24	0.95	0.05

110665	0	2	0.00	2.24	0.95	0.05
250665	0	2	0.00	2.24	0.95	0.05
300466	0	2	0.00	2.24	0.95	0.05
140566	0	2	0.00	2.24	0.95	0.05
280566	0	2	0.00	2.24	0.95	0.05
110666	0	2	0.00	2.24	0.95	0.05
250666	0	2	0.00	2.24	0.95	0.05
300467	0	2	0.00	2.24	0.95	0.05
140567	0	2	0.00	2.24	0.95	0.05
280567	0	2	0.00	2.24	0.95	0.05
110667	0	2	0.00	2.24	0.95	0.05
250667	0	2	0.00	2.24	0.95	0.05
300468	0	2	0.00	2.24	0.95	0.05
140568	0	2	0.00	2.24	0.95	0.05
280568	0	2	0.00	2.24	0.95	0.05
110668	0	2	0.00	2.24	0.95	0.05
250668	0	2	0.00	2.24	0.95	0.05
300469	0	2	0.00	2.24	0.95	0.05
140569	0	2	0.00	2.24	0.95	0.05
280569	0	2	0.00	2.24	0.95	0.05
110669	0	2	0.00	2.24	0.95	0.05
250669	0	2	0.00	2.24	0.95	0.05
300470	0	2	0.00	2.24	0.95	0.05
140570	0	2	0.00	2.24	0.95	0.05
280570	0	2	0.00	2.24	0.95	0.05
110670	0	2	0.00	2.24	0.95	0.05
250670	0	2	0.00	2.24	0.95	0.05
300471	0	2	0.00	2.24	0.95	0.05
140571	0	2	0.00	2.24	0.95	0.05
280571	0	2	0.00	2.24	0.95	0.05
110671	0	2	0.00	2.24	0.95	0.05
250671	0	2	0.00	2.24	0.95	0.05
300472	0	2	0.00	2.24	0.95	0.05
140572	0	2	0.00	2.24	0.95	0.05
280572	0	2	0.00	2.24	0.95	0.05
110672	0	2	0.00	2.24	0.95	0.05
250672	0	2	0.00	2.24	0.95	0.05
300473	0	2	0.00	2.24	0.95	0.05
140573	0	2	0.00	2.24	0.95	0.05
280573	0	2	0.00	2.24	0.95	0.05
110673	0	2	0.00	2.24	0.95	0.05
250673	0	2	0.00	2.24	0.95	0.05
300474	0	2	0.00	2.24	0.95	0.05
140574	0	2	0.00	2.24	0.95	0.05
280574	0	2	0.00	2.24	0.95	0.05
110674	0	2	0.00	2.24	0.95	0.05
250674	0	2	0.00	2.24	0.95	0.05
300475	0	2	0.00	2.24	0.95	0.05
140575	0	2	0.00	2.24	0.95	0.05
280575	0	2	0.00	2.24	0.95	0.05
110675	0	2	0.00	2.24	0.95	0.05
250675	0	2	0.00	2.24	0.95	0.05
300476	0	2	0.00	2.24	0.95	0.05
140576	0	2	0.00	2.24	0.95	0.05
280576	0	2	0.00	2.24	0.95	0.05
110676	0	2	0.00	2.24	0.95	0.05
250676	0	2	0.00	2.24	0.95	0.05
300477	0	2	0.00	2.24	0.95	0.05
140577	0	2	0.00	2.24	0.95	0.05
280577	0	2	0.00	2.24	0.95	0.05
110677	0	2	0.00	2.24	0.95	0.05
250677	0	2	0.00	2.24	0.95	0.05
300478	0	2	0.00	2.24	0.95	0.05
140578	0	2	0.00	2.24	0.95	0.05
280578	0	2	0.00	2.24	0.95	0.05
110678	0	2	0.00	2.24	0.95	0.05
250678	0	2	0.00	2.24	0.95	0.05
300479	0	2	0.00	2.24	0.95	0.05
140579	0	2	0.00	2.24	0.95	0.05
280579	0	2	0.00	2.24	0.95	0.05
110679	0	2	0.00	2.24	0.95	0.05
250679	0	2	0.00	2.24	0.95	0.05
300480	0	2	0.00	2.24	0.95	0.05
140580	0	2	0.00	2.24	0.95	0.05
280580	0	2	0.00	2.24	0.95	0.05
110680	0	2	0.00	2.24	0.95	0.05
250680	0	2	0.00	2.24	0.95	0.05
300481	0	2	0.00	2.24	0.95	0.05

```
  140581  0 2 0.00  2.24 0.95 0.05
  280581  0 2 0.00  2.24 0.95 0.05
  110681  0 2 0.00  2.24 0.95 0.05
  250681  0 2 0.00  2.24 0.95 0.05
  300482  0 2 0.00  2.24 0.95 0.05
  140582  0 2 0.00  2.24 0.95 0.05
  280582  0 2 0.00  2.24 0.95 0.05
  110682  0 2 0.00  2.24 0.95 0.05
  250682  0 2 0.00  2.24 0.95 0.05
  300483  0 2 0.00  2.24 0.95 0.05
  140583  0 2 0.00  2.24 0.95 0.05
  280583  0 2 0.00  2.24 0.95 0.05
  110683  0 2 0.00  2.24 0.95 0.05
  250683  0 2 0.00  2.24 0.95 0.05

*** Record 17: Filtra., disposit. foliar pest. after harvest, and plant uptake ***
     0.0       3     0.0
*** Record 18: Foliar dissipation parameters ***
     0.0     0.0    0.50
Cornelius silt loam, 15% slope, Hydrologic  Group: C
   148.0           0   0   0   0   0   0   0   0   0
*** Record 26: Soil volatilization constants ***
   0.0     0.0   0.0
*** Record 33 ***
       5
*** Record 34 ***
       1    15.0    1.30   0.329     0.0     0.0    0.0
*** Record 36: Soil half-life rate constants; repeat for each horizon ***
          0.058   0.058   0.0
*** Record 37:  ***
            0.1   0.329   0.099    2.30    3.0
*** Record 39: Omitted; parent/daughter transformation rates ***
       2    13.0    1.38   0.338     0.0     0.0    0.0
          0.029   0.029   0.0
            1.0   0.338   0.108    1.11    3.0
       3    15.0    1.58   0.340     0.0     0.0    0.0
          0.029   0.029   0.0
            1.0   0.340   0.110    0.21    3.0
       4    55.0    1.52   0.358     0.0     0.0    0.0
          0.029   0.029   0.0
            5.0   0.358   0.148   0.145    3.0
       5    50.0    1.46   0.202     0.0     0.0    0.0
          0.029   0.029   0.0
            5.0   0.202   0.142    0.07    3.0
       0
         YEAR       5           YEAR       5           YEAR       5   1
       1
       1  -----
       6   YEAR
    PRCP   TSER   0   0
    RUNF   TSER   0   0
    ESLS   TSER   0   0   1.0E3
    RFLX   TSER   0   0   1.0E5
    EFLX   TSER   0   0   1.0E5
    RZFX   TSER   0   0   1.0E5
```

```
*** PRZM2 Version 3.12 Input Data File ***
*** MNSUGAR1.inp Index Reservoir Scenario created on 12/13/99 ***
*** Modified for CABRBARYL 6/21/00 by Laurence Libelo ***
*** Bearden soil is a Benchmark soil with ca. 800K mapped acres in MLRA 56 ***
*** Sugar beets, conventional tillage ***
*** Highest acreage sugarbeet state is MN; highest county in MN is Polk ***
*** Manning's N value set to 0.02 for residues applied to fallow surfaces ***
*** Application timing information provided by Russ Severson (?),
*** University of Minnesota Agricultural Extension Service, Polk County, MN,
*** (218) 281-8696
*** PCA for sugarbeets not available, use default PCA of 0.87 ***
Chemical: Carbaryl
Bearden Silty Clay Loam; HYGP: C; MLRA F-56, Polk County, Minnesota
   0.760   0.500       0   12.00       1       3
       4
    0.28    0.12    0.50      10               3    3.00    354.0
       1
       1    0.10   20.00   80.00       3  91  82  91                0.00   100.00
       1       3
0101 1605 1110
0.43 0.18 0.43
0.02 0.02 0.02
      36
  160548  061048  161048       1
  160549  061049  161049       1
  160550  061050  161050       1
  160551  061051  161051       1
  160552  061052  161052       1
  160553  061053  161053       1
  160554  061054  161054       1
  160555  061055  161055       1
  160556  061056  161056       1
  160557  061057  161057       1
  160558  061058  161058       1
  160559  061059  161059       1
  160560  061060  161060       1
  160561  061061  161061       1
  160562  061062  161062       1
  160563  061063  161063       1
  160564  061064  161064       1
  160565  061065  161065       1
  160566  061066  161066       1
  160567  061067  161067       1
  160568  061068  161068       1
  160569  061069  161069       1
  160570  061070  161070       1
  160571  061071  161071       1
  160572  061072  161072       1
  160573  061073  161073       1
  160574  061074  161074       1
  160575  061075  161075       1
  160576  061076  161076       1
  160577  061077  161077       1
  160578  061078  161078       1
  160579  061079  161079       1
  160580  061080  161080       1
  160581  061081  161081       1
  160582  061082  161082       1
  160583  061083  161083       1
Application Schedule: 2 aerial app @ 1.5 lb a.i./ acre (1.68 kg/ha, 95% app. eff, 16% spray drift
      72       1       0       0
Carbaryl: Kd: 3.0; AeSM: T1/2 = 12 days; AnSM: T1/2 = 24 days
  300448  0 2 0.00  1.68 0.95 0.16
  140548  0 2 0.00  1.68 0.95 0.16
  300449  0 2 0.00  1.68 0.95 0.16
  140549  0 2 0.00  1.68 0.95 0.16
  300450  0 2 0.00  1.68 0.95 0.16
  140550  0 2 0.00  1.68 0.95 0.16
  300451  0 2 0.00  1.68 0.95 0.16
  140551  0 2 0.00  1.68 0.95 0.16
  300452  0 2 0.00  1.68 0.95 0.16
  140552  0 2 0.00  1.68 0.95 0.16
  300453  0 2 0.00  1.68 0.95 0.16
  140553  0 2 0.00  1.68 0.95 0.16
  300454  0 2 0.00  1.68 0.95 0.16
  140554  0 2 0.00  1.68 0.95 0.16
```

```
  300455  0 2 0.00  1.68 0.95 0.16
  140555  0 2 0.00  1.68 0.95 0.16
  300456  0 2 0.00  1.68 0.95 0.16
  140556  0 2 0.00  1.68 0.95 0.16
  300457  0 2 0.00  1.68 0.95 0.16
  140557  0 2 0.00  1.68 0.95 0.16
  300458  0 2 0.00  1.68 0.95 0.16
  140558  0 2 0.00  1.68 0.95 0.16
  300459  0 2 0.00  1.68 0.95 0.16
  140559  0 2 0.00  1.68 0.95 0.16
  300460  0 2 0.00  1.68 0.95 0.16
  140560  0 2 0.00  1.68 0.95 0.16
  300461  0 2 0.00  1.68 0.95 0.16
  140561  0 2 0.00  1.68 0.95 0.16
  300462  0 2 0.00  1.68 0.95 0.16
  140562  0 2 0.00  1.68 0.95 0.16
  300463  0 2 0.00  1.68 0.95 0.16
  140563  0 2 0.00  1.68 0.95 0.16
  300464  0 2 0.00  1.68 0.95 0.16
  140564  0 2 0.00  1.68 0.95 0.16
  300465  0 2 0.00  1.68 0.95 0.16
  140565  0 2 0.00  1.68 0.95 0.16
  300466  0 2 0.00  1.68 0.95 0.16
  140566  0 2 0.00  1.68 0.95 0.16
  300467  0 2 0.00  1.68 0.95 0.16
  140567  0 2 0.00  1.68 0.95 0.16
  300468  0 2 0.00  1.68 0.95 0.16
  140568  0 2 0.00  1.68 0.95 0.16
  300469  0 2 0.00  1.68 0.95 0.16
  140569  0 2 0.00  1.68 0.95 0.16
  300470  0 2 0.00  1.68 0.95 0.16
  140570  0 2 0.00  1.68 0.95 0.16
  300471  0 2 0.00  1.68 0.95 0.16
  140571  0 2 0.00  1.68 0.95 0.16
  300472  0 2 0.00  1.68 0.95 0.16
  140572  0 2 0.00  1.68 0.95 0.16
  300473  0 2 0.00  1.68 0.95 0.16
  140573  0 2 0.00  1.68 0.95 0.16
  300474  0 2 0.00  1.68 0.95 0.16
  140574  0 2 0.00  1.68 0.95 0.16
  300475  0 2 0.00  1.68 0.95 0.16
  140575  0 2 0.00  1.68 0.95 0.16
  300476  0 2 0.00  1.68 0.95 0.16
  140576  0 2 0.00  1.68 0.95 0.16
  300477  0 2 0.00  1.68 0.95 0.16
  140577  0 2 0.00  1.68 0.95 0.16
  300478  0 2 0.00  1.68 0.95 0.16
  140578  0 2 0.00  1.68 0.95 0.16
  300479  0 2 0.00  1.68 0.95 0.16
  140579  0 2 0.00  1.68 0.95 0.16
  300480  0 2 0.00  1.68 0.95 0.16
  140580  0 2 0.00  1.68 0.95 0.16
  300481  0 2 0.00  1.68 0.95 0.16
  140581  0 2 0.00  1.68 0.95 0.16
  300482  0 2 0.00  1.68 0.95 0.16
  140582  0 2 0.00  1.68 0.95 0.16
  300483  0 2 0.00  1.68 0.95 0.16
  140583  0 2 0.00  1.68 0.95 0.16
     0.0       3    0.00
     0.0    0.00    0.50
Bearden Silty Clay Loam; Hydrologic Group C;
  100.00           0   0   0   0   0   0   0   0   0
    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
       4
       1   10.00   1.400   0.377   0.000   0.000
           0.58    0.58    0.00
            0.10   0.377   0.207   1.160    3.0
       2    8.00   1.400   0.377   0.000   0.000
           0.029   0.029   0.00
            1.00   0.377   0.207   1.160    3.0
       3   54.00   1.500   0.292   0.000   0.000
           0.029   0.029   0.00
            2.00   0.292   0.132   1.160    3.0
       4   28.00   1.800   0.285   0.000   0.000
           0.029   0.029   0.00
             2.0   0.285   0.125   0.174    3.0
```

```
        0
            YEAR        5            YEAR        5            YEAR        5   1
        1
        1  -----
        1   YEAR
*** PRCP    TSER   0   0***
    RUNF    TCUM   0   0
*** ESLS    TSER   0   0   1.0E3***
*** RFLX    TSER   0   0   1.0E5***
*** EFLX    TSER   0   0   1.0E5***
*** RZFX    TSER   0   0   1.0E5***
```

```
PRZM3 Input File, flcit.inp (Jan 28 2000)
*** original file source unknown ***
*** Source of crop and soil data unknown ***
*** modified for carbaryl by Laurence Libelo, 6/21/00 ***
*** modified for Standard Pond 7/17/2000 ***
*** Use rate changed to QUA (July 21, 1998 QUA Report) AVERAGE VALUES on 2/23/01 ***
Location: Osceola County, FL.; Crop: citrus; MLRA 156A
    0.77    0.15       0   25.00       1       1
       4
    0.10    0.13    1.00    10.0               3   1.00   354.0
       1
       1    0.10  100.00   80.00       3  94  84  89    0.00  100.00
       1       3
0101 21 9 2209
0.10 0.10 0.10
.023 .023 .023
      36
  110548  170748   10848       1
  110549  170749   10849       1
  110550  170750   10850       1
  110551  170751   10851       1
  110552  170752   10852       1
  110553  170753   10853       1
  110554  170754   10854       1
  110555  170755   10855       1
  110556  170756   10856       1
  110557  170757   10857       1
  110558  170758   10858       1
  110559  170759   10859       1
  110560  170760   10860       1
  110561  170761   10861       1
  110562  170762   10862       1
  110563  170763   10863       1
  110564  170764   10864       1
  110565  170765   10865       1
  110566  170766   10866       1
  110567  170767   10867       1
  110568  170768   10868       1
  110569  170769   10869       1
  110570  170770   10870       1
  110571  170771   10871       1
  110572  170772   10872       1
  110573  170773   10873       1
  110574  170774   10874       1
  110575  170775   10875       1
  110576  170776   10876       1
  110577  170777   10877       1
  110578  170778   10878       1
  110579  170779   10879       1
  110580  170780   10880       1
  110581  170781   10881       1
  110582  170782   10882       1
  110583  170783   10883       1
Application at "average" value from QUA (July 21, 1998 QUA Report) 2 apps / 3.4 lb a.i. per app
*** Application: 4 aerial appls @ 5 lb a.i./ac/year (5.6 kg/ha) @95% eff, w/5%drift
      72       1       0       0
CARBARYL on FL Cirtus
  300448  0 2 0.00  3.81 0.95 0.05
  140548  0 2 0.00  3.81 0.95 0.05
  300449  0 2 0.00  3.81 0.95 0.05
  140549  0 2 0.00  3.81 0.95 0.05
  300450  0 2 0.00  3.81 0.95 0.05
  140550  0 2 0.00  3.81 0.95 0.05
  300451  0 2 0.00  3.81 0.95 0.05
  140551  0 2 0.00  3.81 0.95 0.05
  300452  0 2 0.00  3.81 0.95 0.05
  140552  0 2 0.00  3.81 0.95 0.05
  300453  0 2 0.00  3.81 0.95 0.05
  140553  0 2 0.00  3.81 0.95 0.05
  300454  0 2 0.00  3.81 0.95 0.05
  140554  0 2 0.00  3.81 0.95 0.05
  300455  0 2 0.00  3.81 0.95 0.05
  140555  0 2 0.00  3.81 0.95 0.05
  300456  0 2 0.00  3.81 0.95 0.05
  140556  0 2 0.00  3.81 0.95 0.05
  300457  0 2 0.00  3.81 0.95 0.05
```

```
   140557  0 2 0.00  3.81 0.95 0.05
   300458  0 2 0.00  3.81 0.95 0.05
   140558  0 2 0.00  3.81 0.95 0.05
   300459  0 2 0.00  3.81 0.95 0.05
   140559  0 2 0.00  3.81 0.95 0.05
   300460  0 2 0.00  3.81 0.95 0.05
   140560  0 2 0.00  3.81 0.95 0.05
   300461  0 2 0.00  3.81 0.95 0.05
   140561  0 2 0.00  3.81 0.95 0.05
   300462  0 2 0.00  3.81 0.95 0.05
   140562  0 2 0.00  3.81 0.95 0.05
   300463  0 2 0.00  3.81 0.95 0.05
   140563  0 2 0.00  3.81 0.95 0.05
   300464  0 2 0.00  3.81 0.95 0.05
   140564  0 2 0.00  3.81 0.95 0.05
   300465  0 2 0.00  3.81 0.95 0.05
   140565  0 2 0.00  3.81 0.95 0.05
   300466  0 2 0.00  3.81 0.95 0.05
   140566  0 2 0.00  3.81 0.95 0.05
   300467  0 2 0.00  3.81 0.95 0.05
   140567  0 2 0.00  3.81 0.95 0.05
   300468  0 2 0.00  3.81 0.95 0.05
   140568  0 2 0.00  3.81 0.95 0.05
   300469  0 2 0.00  3.81 0.95 0.05
   140569  0 2 0.00  3.81 0.95 0.05
   300470  0 2 0.00  3.81 0.95 0.05
   140570  0 2 0.00  3.81 0.95 0.05
   300471  0 2 0.00  3.81 0.95 0.05
   140571  0 2 0.00  3.81 0.95 0.05
   300472  0 2 0.00  3.81 0.95 0.05
   140572  0 2 0.00  3.81 0.95 0.05
   300473  0 2 0.00  3.81 0.95 0.05
   140573  0 2 0.00  3.81 0.95 0.05
   300474  0 2 0.00  3.81 0.95 0.05
   140574  0 2 0.00  3.81 0.95 0.05
   300475  0 2 0.00  3.81 0.95 0.05
   140575  0 2 0.00  3.81 0.95 0.05
   300476  0 2 0.00  3.81 0.95 0.05
   140576  0 2 0.00  3.81 0.95 0.05
   300477  0 2 0.00  3.81 0.95 0.05
   140577  0 2 0.00  3.81 0.95 0.05
   300478  0 2 0.00  3.81 0.95 0.05
   140578  0 2 0.00  3.81 0.95 0.05
   300479  0 2 0.00  3.81 0.95 0.05
   140579  0 2 0.00  3.81 0.95 0.05
   300480  0 2 0.00  3.81 0.95 0.05
   140580  0 2 0.00  3.81 0.95 0.05
   300481  0 2 0.00  3.81 0.95 0.05
   140581  0 2 0.00  3.81 0.95 0.05
   300482  0 2 0.00  3.81 0.95 0.05
   140582  0 2 0.00  3.81 0.95 0.05
   300483  0 2 0.00  3.81 0.95 0.05
   140583  0 2 0.00  3.81 0.95 0.05
       0.        1
     0.00   0.000    0.50
Soil Series: Adamsville sand; Hydrogic Group C
*** Kd for sandy loam = 1.7
   100.00          0   0   0   0   0   0   0   0   0
   00.0    0.00     00.00
       3
       1  10.000   1.440   0.086   0.000   0.000   0.000
          .058    .058     0.000
           0.100   0.086   0.036   0.580     1.7
       2  10.000   1.440   0.086   0.000   0.000   0.000
          .029    .029     0.000
           1.000   0.086   0.036   0.580     1.7
       3  80.000   1.580   0.030   0.000   0.000   0.000
          .029    .029     0.000
           5.000   0.030   0.023   0.116     1.7
       0
     WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       6
      11  -----
       1    DAY
     RUNF    TSER   0   0   1.E0
```